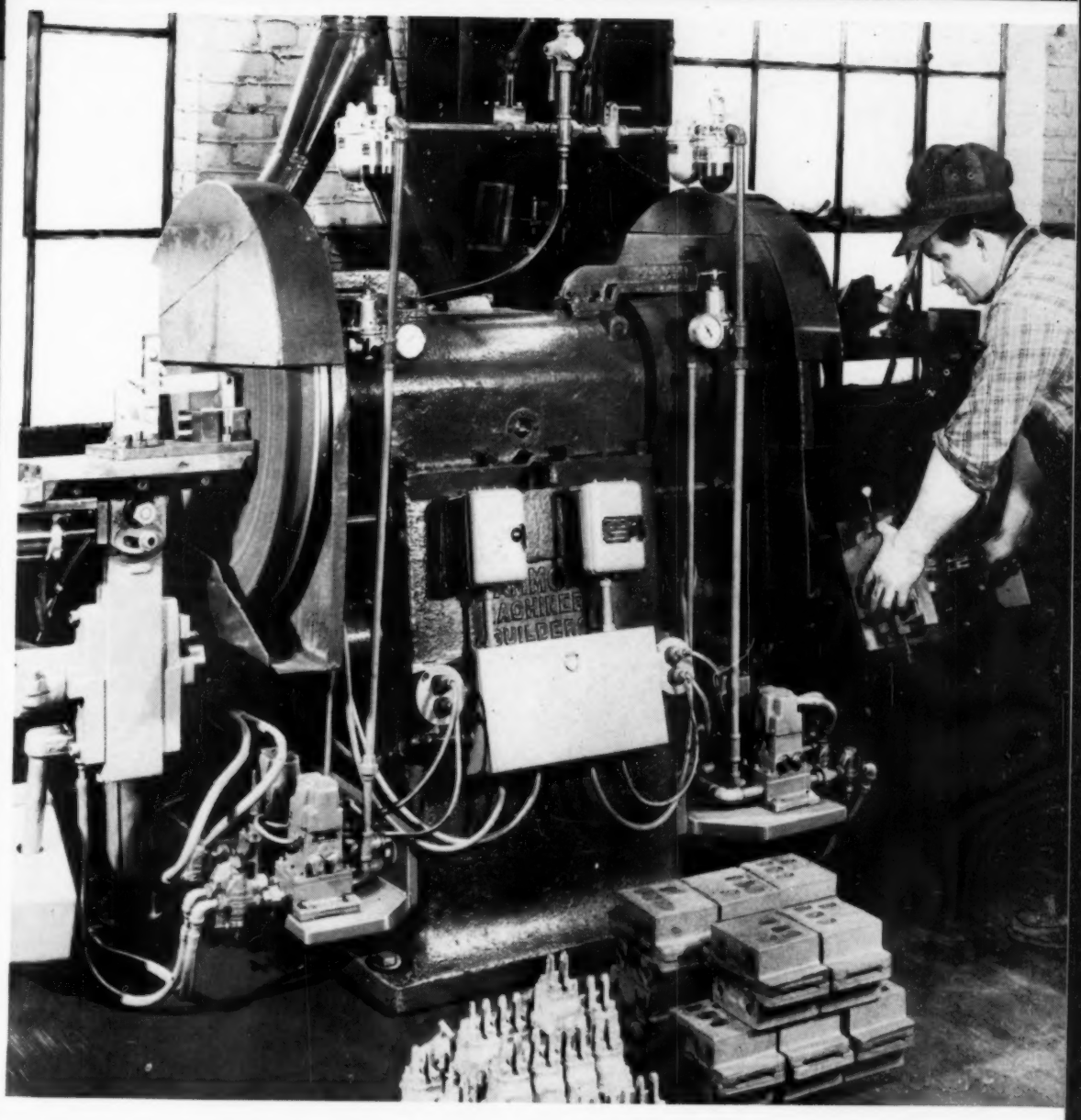
# APPLIED HYDRAULICS

THE MAGAZINE OF FLUID POWER TRANSMISSION

APRIL, 1950

- HYDRAULICS CIRCUITS
- HYDRAULIC CONTROLS
- AIR CIRCUITS
- AIR CONTROLS
- ELECTRICAL AND ELECTRONIC CONTROLS



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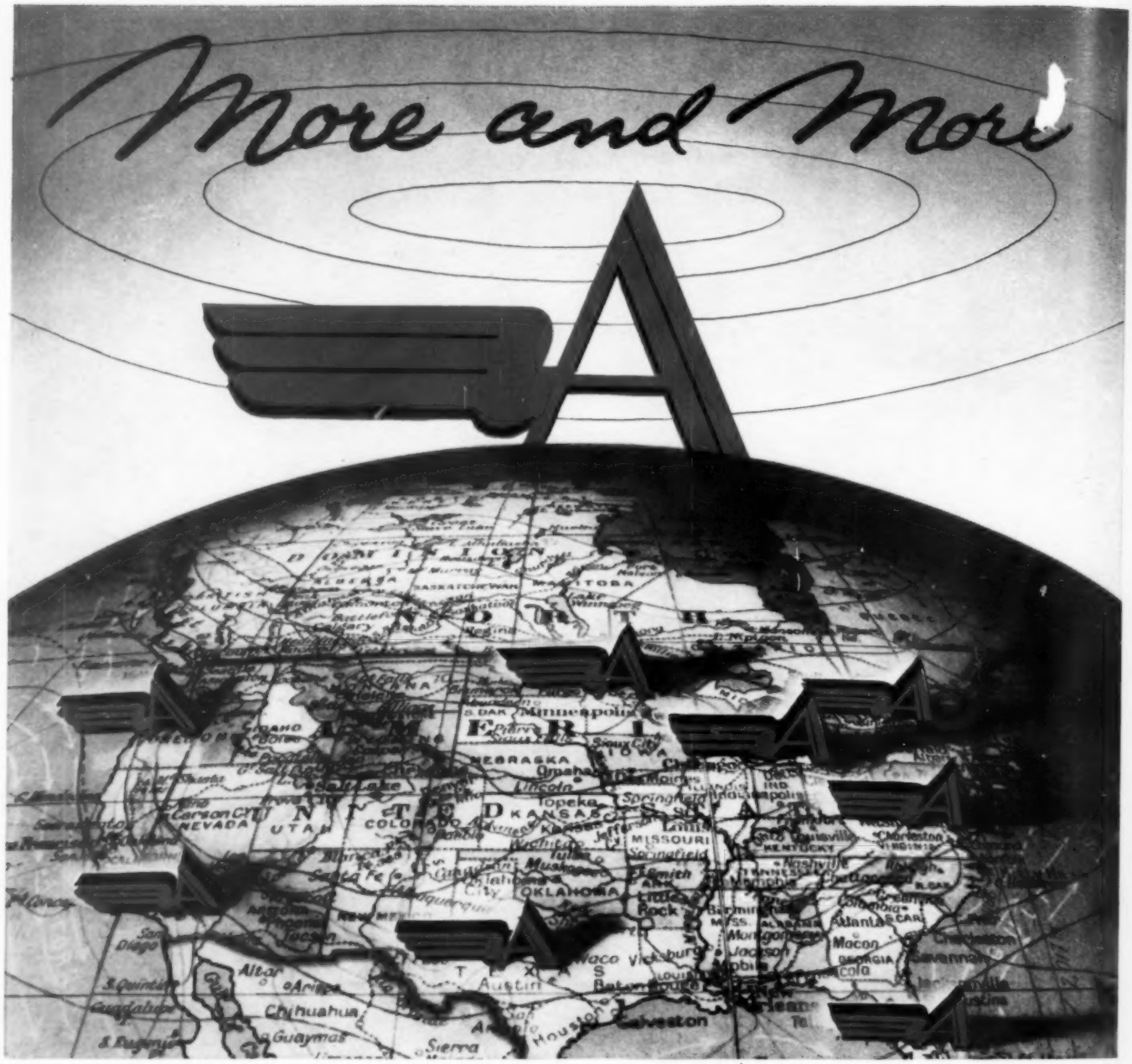


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APRIL, 1950
Vol. 3 No. 3

# APPLIED HYDRAULICS

*The Magazine of Fluid Power Transmission*

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LESTER P. AURBACH, V. Pres.

JEROME H. PESKIN
General Manager

PAUL L. REED
Editor

Production Department
WILLIAM L. JERSE

Circulation Department
E. M. JOSEPH
Director

Editorial and Business Office
1240 Ontario Street
Cleveland 13, Ohio
Phone: TOwer 1-0264
AT&T Teletypewriter Number is CV-233

NEW YORK OFFICE
STEPHEN SHEPARD
60 East 42nd Street
Room 805
New York 17, N. Y.
MUrray Hill 7-3420

CHICAGO OFFICE
CHARLES G. HEALY
Room 734
520 N. Michigan Ave.
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LOS ANGELES OFFICE
FRED W. FRISENFELDT
Industrial Publishing Co.
Room 403
1250 Wilshire Blvd.
Los Angeles 17, Calif.
TUcker 6703

Applied Hydraulics is indexed regularly by Engineering Index, Inc.

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**FRONT COVER:** A twin disc horizontal grinder as set up for semi-automatic operation of loading fixtures by the incorporation of standard economical air circuits. See story on page 19.

*Photo courtesy Ross Operating Valve Co.*

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Published monthly by THE HYDRAULICS PUBLISHING CO., an affiliate of INDUSTRIAL PUBLISHING CO., publishers of COMMERCIAL REFRIGERATION AND AIR CONDITIONING, DIE CASTINGS. FLOW, INDUSTRY & WELDING, OCCUPATIONAL HAZARDS, and THE TAXICAB INDUSTRY. Member, Controlled Circulation Audit, Inc., and National Business Paper Association.

Subscription rates: United States and possessions—$3.00 per year, $5.00 for 2 years; Canada—$4.00 per year, $6.00 for 2 years; Foreign—$5.00 per year. Single copy price, 30 cents. All subscriptions subject to individual acceptance by the publisher.

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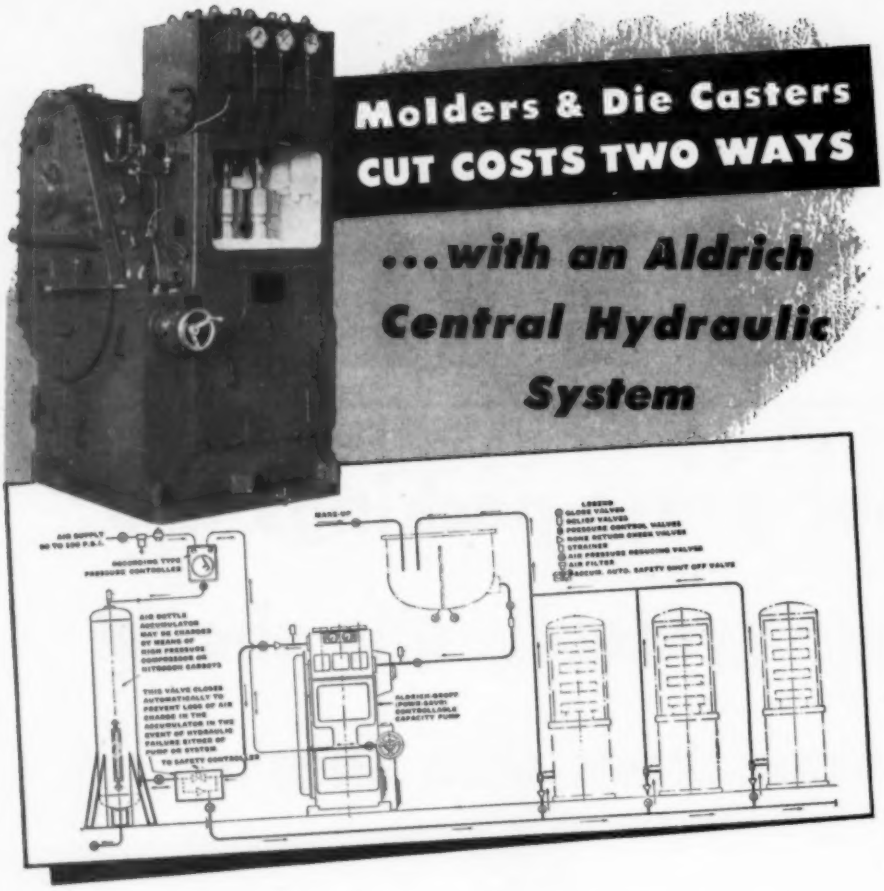

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We have been trying in vain for years to get information on hydraulics and still hope to get a basic education in the field before too long. The farmers in this community are very keen on hydraulic controlled implements and we must keep at least a step ahead of them.

J.R.R.

P.S. We have waited long enough to find this magazine and want to get started "cramming".

*We are sending you enough information to get you started and will also put your name on the list to receive our list of books, manuals and literature which is now being prepared.*

---

The department that I have found most interesting in your magazine is the "Here's How" page. I have already used the method for checking the source of an air leak you printed in January. How about printing more of these each month?

J.L.

*We will print more as more items come to us and as space is available. You can help by sending us one yourself. Starting with this issue, as noted elsewhere, we will pay a premium for the "editor's choice" of the best items received each month.*

---

I am a very recent addition to your list of readers. In looking around for ways and means of getting some "refresher" courses and literature, I read a letter from J.L. and B.R. in your January column. It seems that their requirements are very similar to mine. Do you know of any evening courses in hydraulics being offered in the Los Angeles area? Please send a list of helpful books, manuals and data sheets. And thanks a lot.

R.B.B.

*The only evening "course" in hydraulics in the Los Angeles area we know of is the monthly meetings being held by the Committee on Hydraulic and Pneumatic Systems, Southern California Section, ASME. The supply of the list of books, manuals and data sheets has been exhausted due to the demand and a larger list, now in preparation, will be sent to you as soon as available.*

---

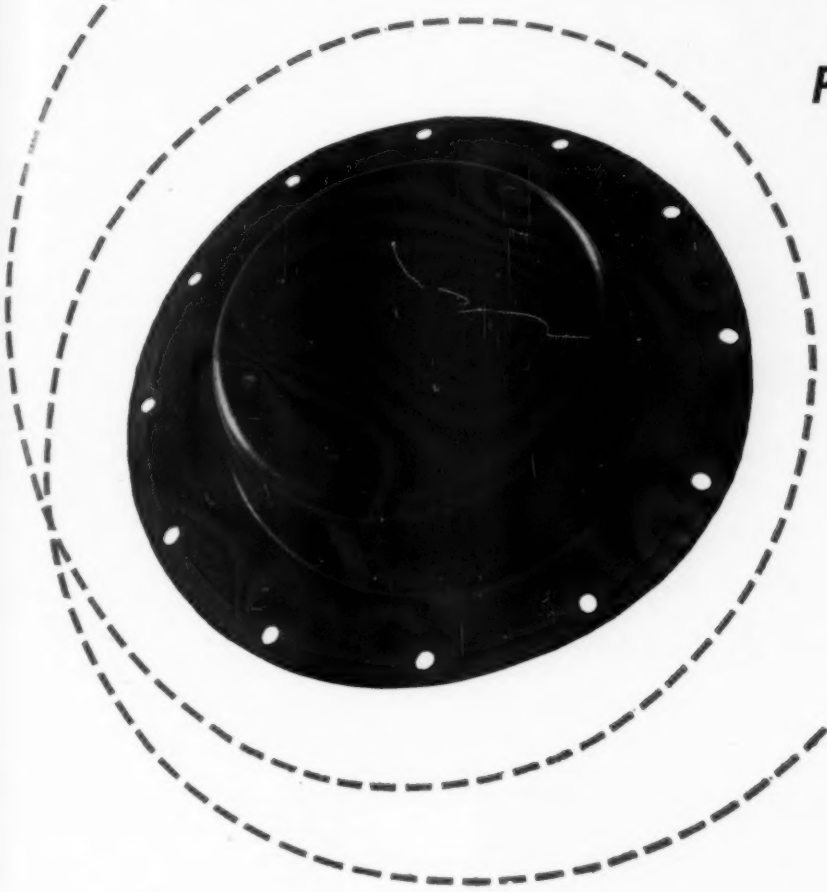
We would like to see more articles and information on control components printed in your magazine. In a recent article all you said about the control circuit was "electric interlocks assure the proper sequence and safe operation". Maybe we are asking too much but couldn't you get more information in installation stories on how the hydraulic or air circuit was controlled?

D.H.

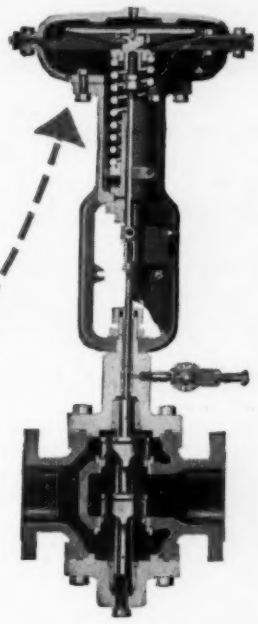
*Our agenda for this year calls for more data on controls and control*

*(Continued on page 14)*

# Keeping the Pulse of Automatic Control . . . with a LINEAR MOULDED DIAPHRAGM



***A Special LINEAR Precision Moulded Diaphragm is the heart of this Honeywell Series 700 Control Valve***



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. . . provides a pressure-tight seal without strain on the cast flange.

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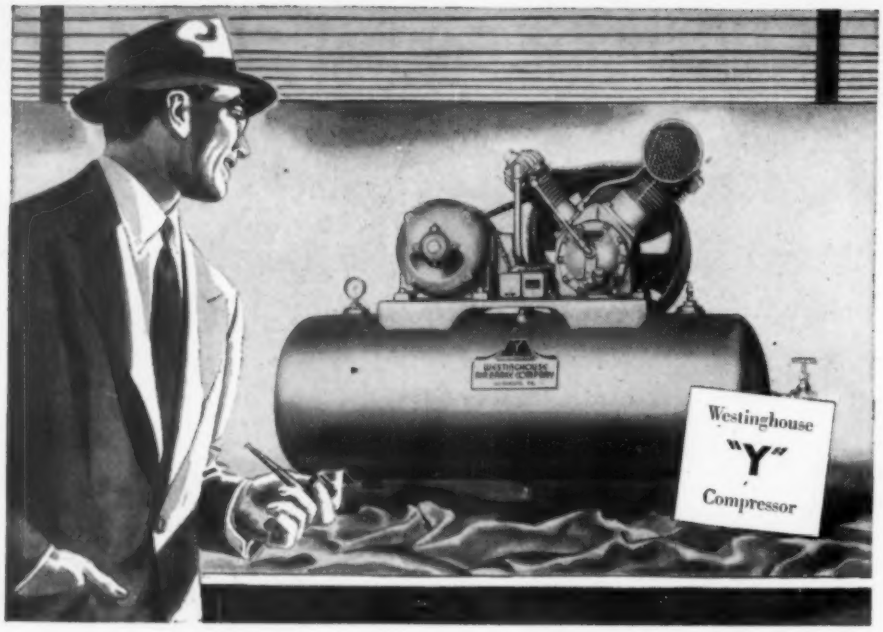


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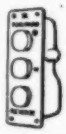

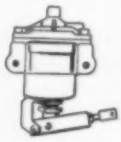

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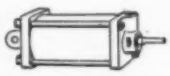

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*(Continued from page 12)*

*circuits. An article in this issue on pressure actuated switches is part of our plan to give more space to controls.*

---

In the "Letters to the Editor" in your March issue, W.J.C. asks for a source of high pressure hose. We have a hose that has been manufactured especially to withstand very high pressures and pressure impulses. However, it is expensive to make and the cost runs quite a bit higher than conventional hose. This hose would be economical in cases where stops or breakdowns of regular hose would cost more than the premium cost of the better hose.

J.H.M.

*The name of this manufacturer also has been forwarded to W.J.C.*

---

Please print more circuit diagrams. We have found these most helpful in our regular work.

B.R.

*We try to get both hydraulic and electrical circuits for each of our application and installation stories. We also like to have circuit diagrams in our "Here's How" department. We promise to get as many circuit diagrams as possible into each issue.*

---

I ran across an article in an old issue of your magazine, "Trouble Shooting in Hydraulic Systems", written by Carl Linde. Could I have the complete series?

D.H.

*The two parts of this series, which ran in August and November, 1948, have been forwarded to you.*

I would like to know if you can give me information concerning correspondence course in hydraulics. My line of work permits me to work on hydraulic machines of all kinds. I usually get your magazine from my foreman and I really appreciate the information in each issue.

R.T.D.

*We are sending you the very limited information we have. It seems that correspondence schools lag somewhat behind the demand for such courses. However, we are bringing to the attention of several schools that offer similar engineering courses, the fact that a steadily increasing number of men are asking for such courses. We'll keep our readers posted on progress in this column.*

---

Would it be practical for you to list in your column the articles that have been reprinted? It would help our clipping problem as well as be a good addition to our sales work sheets.

P.K.
B.S.

*This is a good suggestion. Usually reprints are ordered by individual companies or individuals who have authored such articles. We have put this suggestion in our "Must Do" file.*

### Your Ideas

*Share your ideas on "Here's How I Do It." The Editor will pay $10.00 for the idea considered best for the month.*

# Production Increased 400 Percent

**An air circuit installation to provide semi-automatic operation of loading fixtures and feed of a twin disc horizontal grinder to give greater uniformity of product and an increase in production.**

**By F. W. HICKS**

AN INTERESTING APPLICATION OF air as applied to a twin disc horizontal grinder at the Ross Operating Valve Co. of Detroit resulted in a 400 per cent increase in production and greater uniformity of product at an approximate investment of $500.00.

Figures 1 and 2 are views of the grinder equipped with the air circuits which gave semi-automatic operation at such a low cost. Figure 2 shows the right grinding fixture in the loading position, with the table retracted from the grinding wheel. On the left, the grinding fixture is shown in position for the grinding cycle. The equipment setup on each wheel is identical; timing permitting one operator to load and unload the fixtures alternately.

Figure 1 is a closeup of the left grinding fixture, showing the loading and positioning cylinder (behind counterweight), the operating linkage, cam "A" (see Figure 3), the two four-way solenoid valves, the speed control valves and lubricators. The end of the horizontal in-feed cylinder, under the loading table ("Y" in Figure 3), is also shown.

Figures 3 and 4 are schematic representations of the air circuits and electrical circuits required to produce the desired sequence of operations.

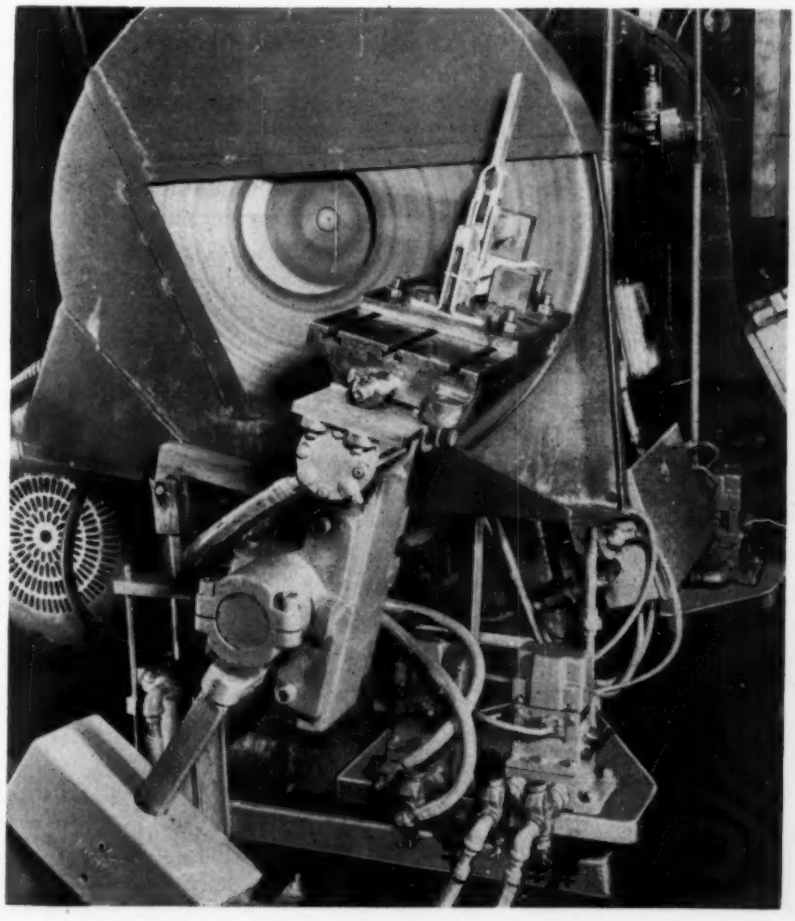


**Fig. 1. A closeup of the left grinding fixture. The loading and positioning air cylinder (partially behind the counterweight), operating linkage, cam "A", solenoid and speed control valves and in-feed cylinder (base of loading table) are shown.**

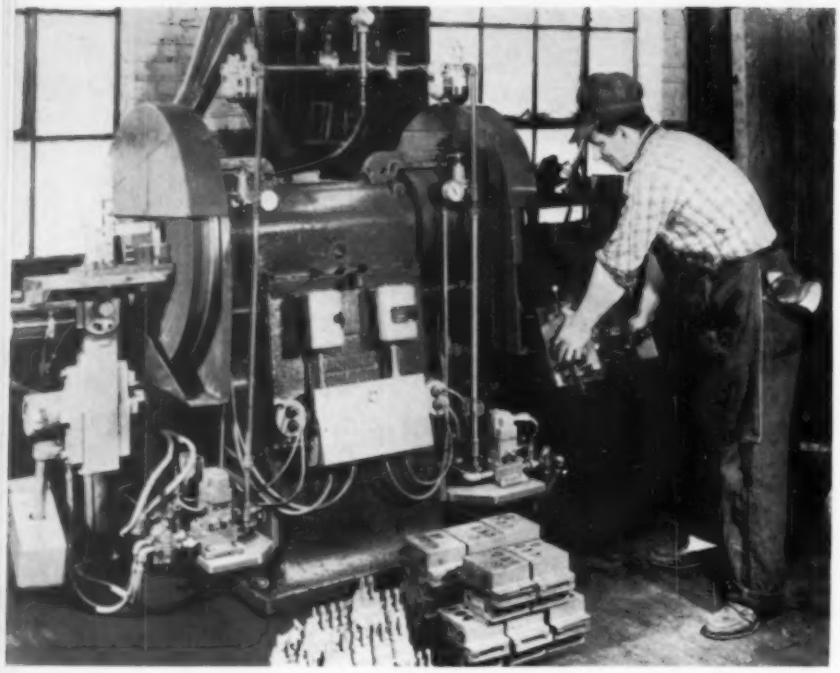


**Fig. 2. A front view of the twin disc grinder showing the operator loading the right fixture while the left goes through its grinding cycle.**

At the start of each cycle, the piston of clevis-mounted air cylinder "X" (3 in bore, 10 in stroke), is extended and the loading table is retracted from the grinding wheel. In this position, normally open limit switch No. 1 (LS1) is held closed by contact of cam "A". The cycle is initiated by pressing starting button of the time relay (see Figure 4).

This action energizes relay No. 1 and solenoid No. 1, in turn. Air is introduced in the rod end of cylinder "X" and the table moves across the grinding wheel parallel to the face. The cylinder rod retracts until cam "A" contacts and reverses LS2. This causes two actions to occur simultaneously—LS2 energizes relay No. 2 and solenoid No. 2. This permits air to be introduced into the rod end of cylinder "Y", advancing work into the grinding wheel.

At the same time, relay No. 1 and solenoid No. 1 are de-energized, reversing the valve and introducing air into the blank end of cylinder "X". Cam "B" then contacts LS1 and the rod of cylinder "X" retracts. This oscillating motion across the grinding wheel continues until the entire circuit is de-energized.

Length of stroke across the grinding wheel is controlled by adjustment of cam "B" to suit the part being ground. At the end of the time cycle, all relays and solenoids are de-energized and the table returns to the loading position.

Speed controls are adjustable to permit the withdrawal of the work table before the table returns to the loading position. Speed controls also control the speed of oscillating motion and the in-feed of the table. Pressure of the part against the grinding wheel is controlled through the pressure regulator, which is adjusted to give the required pressure on cylinder "Y" to suit the material being ground and the type of wheel used. Controlled pressures and full use of the entire face of the wheel result in longer wheel life and require fewer dressings of the wheel.

**Fig. 3. Schematic diagram of the air circuit.**

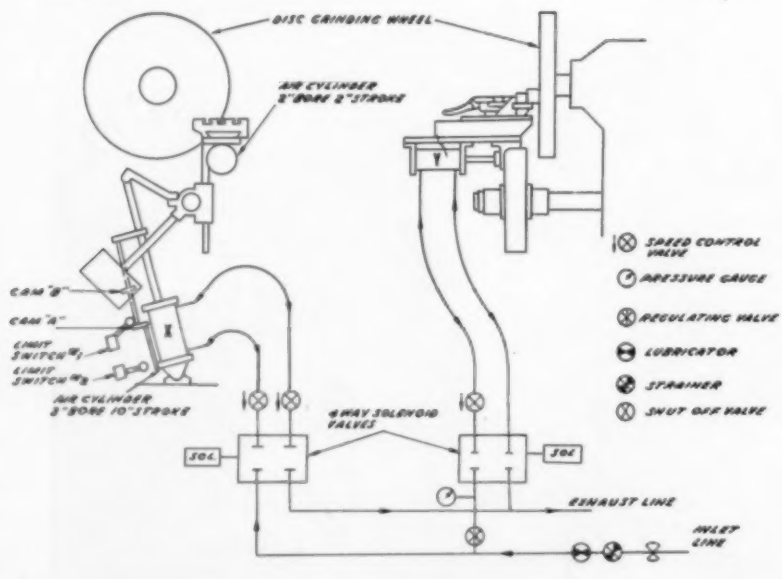
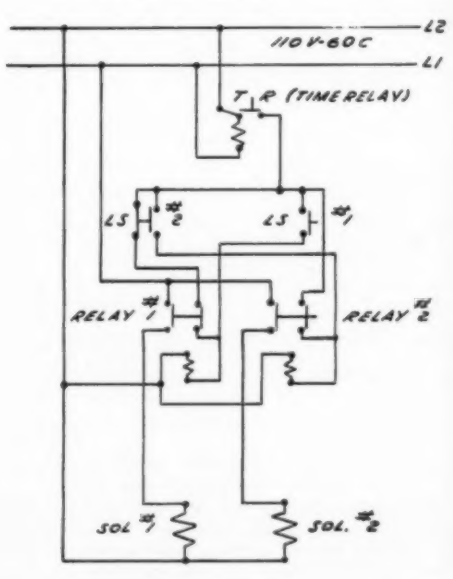



**Fig. 4. Wiring diagram for the operation of the air circuit.**



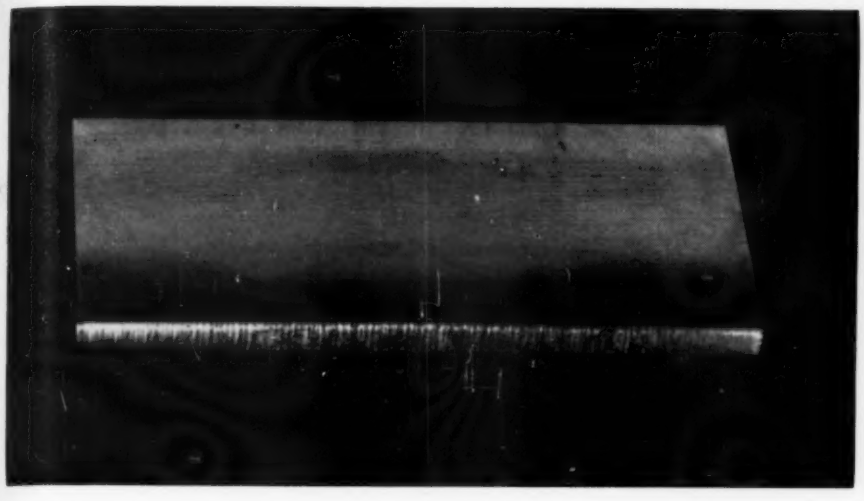


**Fig. 1. Varnish deposits on a pump vane which required a shutdown and replacement. This condition is caused by local overheating of oil at the pump orifices.**

# WHY TREATED HYDRAULICS OILS?

**A leading specialist outlines the advantages in service characteristics of the use of accurate and correctly chosen inhibitors in hydraulic oils for specific conditions.**

**By FRANK ROSS**

**Manager, Lubrication Dept.**
**E. F. Houghton & Co.**

THE DEVELOPMENT OF ADDITIVE treatment of industrial oils is not as clear-cut a picture as in the case of automotive lubricants. Growth of the use of industrial lubricant additives has largely been due to individual company research, rather than an industry-wide movement such as the automotive lubrication field witnessed a decade or more ago. In some instances developments of materials designed to improve oils for internal combustion engines and diesels have been used as industrial oil additives, but with varying degrees of success. By and large the two movements were not tied in with each other.

Additive-treated hydraulic oils were first put on the market in the middle 1930s, in relative small quantities. For almost five years the pioneers of treated hydraulic oils had the problem of trying to convince pump manufacturers and machine tool builders that: first, treated oils would give longer and more trouble-free service, and secondly, such oils would be harmless to the finely machined working parts of a hydraulic mechanism. Unfortunately, progress in this educational program was materially retarded in 1941 when a large marketer of hydraulic oils prematurely released an improperly treated hydraulic oil which seemed to convince the skeptics.

Shortly afterward, one of the leading pump manufacturers published a warning in its instruction sheets against promiscuous use of treated hydraulic oils. It was so broad as to almost eliminate additive oils from consideration in operation of their pumps.

Meanwhile, research continued, in an effort to improve hydraulic oils for their special functions. Although no definite progress was made to market such oils until about the close of the war we find that the service benefits from the use of treated hydraulic fluids were recognized.*

About the same time marketers of hydraulic oils to industry began to capitalize on experience gained in war-time aircraft hydraulic research. The demands for protection imposed on shipments of hydraulic equipment to government agencies in various parts of the world under severe climatic conditions, in particular, was in large part responsible for the widespread acceptance of rust inhibitors recently being regarded as an essential in hydraulic oils.

The position that "there is no need for additives in hydraulic oils", the general theme of hydraulic engineers and marketers of untreated oils during the late '30s and early '40s, has now been shifted to a realization that service life of such oils will be definitely extended by the use of proper and compatible additives.

The basic, essential properties of a good hydraulic oil have been recounted many times. Such properties include high viscosity indices, high oxidation stability, good demulsibility and freedom from impurities. The purpose of this article is not to dwell on the necessity for these and

---

* *V. M. Drost, "Hydraulic Oils for Machine Tools", Machinery, June, 1944; Vol. 50, No. 10, p. 157.*
*W. C. Huebler, "Additives Improve Hydraulic Oils", American Machinist, June 21, 1945; Vol. 89, p. 110.*

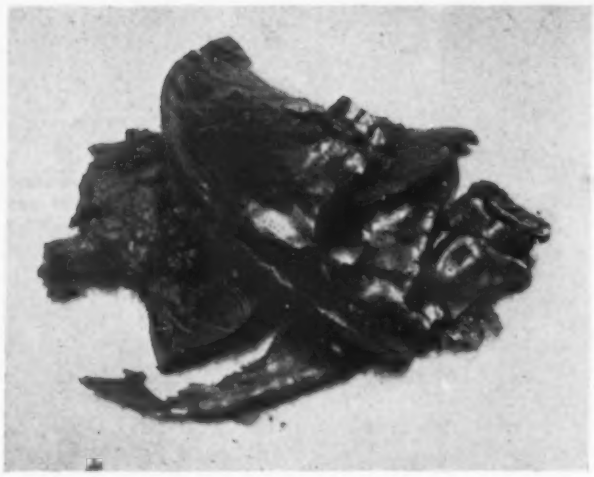


Fig. 2. Sludge taken from the hydraulic system of a machine tool. This sludge, caused by lack of oxidation resistance of the oil used, required a tear down and overhaul of the system.

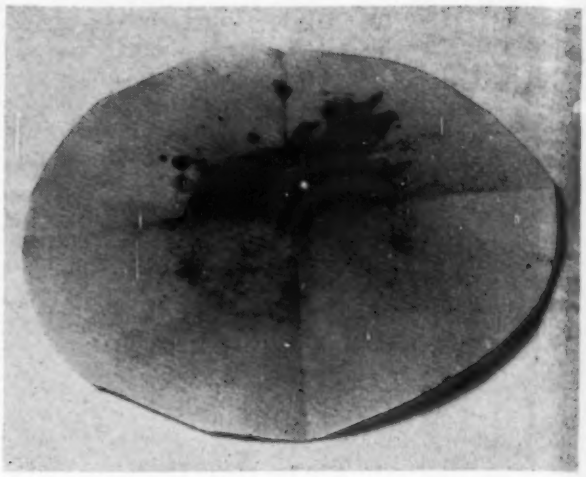


Fig. 3. Sludge contamination surrounding a ball check valve as taken from the hydraulic system of a milling machine. The sludge resulted in sluggish operation and chatter requiring and expensive overhaul.

other properties, but rather to discuss additives being currently used in hydraulic oils now on the market, and how they benefit the user.

We must begin by assuming that the proper viscosity oil is used; that the mechanical efficiency of the system is good, and that all factors are equal in any comparison between untreated and treated hydraulic oils.

### Oxidation Inhibitors

Aside from the problem of contamination—the greatest bugaboo of all—the one thing that can cause the most trouble in operation of hydraulic system is oxidation of the oil, with resultant gum and varnish deposits that impair operation and necessitate cleaning of valves, ports, pumps and other working parts. Figure 1 shows the varnish deposit on a pump vane. Figure 2 shows chunks of sludge taken from the hydraulic system of a machine tool, which required an early overhaul due to the lack of oxidation resistance of the oil.

To delay such troubles and to extend the service life of the oil, many companies employ oxidation inhibitors. Such agents act as "buffers" and preferentially absorb the oxygen which normally combines with the hydrocarbon and results in oxidation of the oil. Oxygen is thus prevented or delayed from being absorbed by the hydrocarbon structure of the base oil, and the useful life of the original oil is extended.

Obviously, when that extended period has finally passed, the base oils will eventually tend to oxidize in a manner similar to earlier attack on an uninhibited oil. However, the user has, in the meantime gained a reprieve from troubles that normally might be expected in much shorter service periods.

To predict just where this "factor of safety" lies by trying to estimate the actual extension of service life, would be a dangerous guess. Service life of a hydraulic oil, or the benefits derived from an oxidation inhibitor, are dependent on a number of variables which are found even in machines of the same manufacture, used in apparently similar operations. Such factors as ambient temperatures, atmospheric conditions, contamination, type of material being processed, are a few of such variables. They may even range from viscosity, type of pump, pressure and cycling, down to the personal habits of the operator.

A safe statement however, is that oxidation inhibitors incorporated in hydraulic oils in proper proportion will definitely benefit the user by extending the trouble-free life of the oil to a point where the premium paid for such oils is offset by their longer life and freedom from oxidation.

Probably the most graphic description of how such inhibitors function and retard "break-down" of the oil may be found in results obtained from the A.S.T.M. Steam Turbine Oil Oxidation Test (D-943-47T). In the absence of any other standard procedure for testing oxidation characteristics of hydraulic oils, this test is the one most widely used to evaluate inhibited turbine and hydraulic oils.

Essentially the test consists of subjecting a sample of oil to a temperature of 95 C (203 F) in the presence of water, oxygen and an iron-copper catalyst, and determining the time required to build up a neutralization number of 2.0 in the sample.

Table 1 below shows typical results obtained in this test with an uninhibited hydraulic oil and the same base oil treated with an oxidation inhibitor.

Although this test may be classified as too severe for a hydraulic oil operating at sump temperatures between 90 and 130 F, it does give comparative values of anticipated oxidation characteristics of oils with and without additives, and, in some cases serves to furnish comparisons between inhibited oils of various blends and with different additives.

We might point out that the fact that the sump temperature of a hydraulic system may be around 100 F, does not necessarily indicate that higher temperatures are not encountered. As a matter of fact, from the type of varnish deposits found on valves in some systems, indications are that localized temperatures are encountered which will run well in excess of 200 F.

**Fig. 4. A chunk of "gunk"—sludge and pipe compound (oxidized oil and asbestos) taken from the hydraulic system of an injection molding machine.**

The point at which oil is subjected to the most severe punishment is during the valving stage, when it is forced through small orifices at high pressures and resultant high velocities, causing fluid friction and thereby a localized heat condition. Such localized temperatures are rapidly dissipated, of course, in later flow of the oil through the system, and it returns to the sump at a much lower temperature.

However, it is at such points as the above that breakdown of the oil will cause persistent films of gum or varnish on valves and in pump ports, and here is where oxidation-inhibited oils serve their appointed purpose. Figure 3, for example, shows the sludge surrounding a ball check valve taken from a milling machine, which had caused sluggish and chattery operation requiring an overhaul.

## Rust Inhibitors

The use of rust inhibitors in hydraulic oils originated with the demands of machine tool builders. They desired to use oils which could be used to run in or test a hydraulic system, and upon draining, would leave a suitable film of protection against corrosion during shipment. Thereby the mechanism when shipped to its ultimate destination would arrive in good condition, not corroded by atmospheric conditions prevailing during shipment or temporary storage.

The question as to whether or not a hydraulic oil used in ordinary machine shops is in need of a rust inhibitor is one which has never been fully answered.

The practice of using a turbine oil interchangeably as a hydraulic oil, plus the fact that most specifications for hydraulic oil call for rust inhibition, have made the incorporation of such an additive a "must". There has never been any doubt as to the necessity of rust preventive properties in a turbine oil, although some might argue that in a closed hydraulic system rust could not form during normal operating conditions. Rusting has been reported above the line of turbulence of the oil level, which leads to flaking of the rust from the top of the reservoir and results in metallic contamination of the oil supply. Such a condition would often not be appeased by the present additive treatment of a hydraulic oil, as the rust preventive properties of the inhibitors usually used are effective only on actual contact with the metallic surfaces in an action usually described as "plating". Rusting in the sump, as above mentioned, can best be overcome by coating the metal inside with a preservative type of paint, not soluble in hydraulic oil.

If a hydraulic machine is to be taken out of service temporarily, or shipped from one plant to another, the rust preventive properties of a rust-inhibited hydraulic oil would

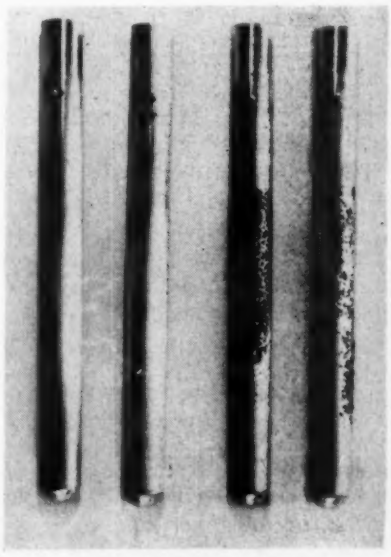
*(Continued on page 43)*

**Table 1. Typical results obtained in the A.S.T.M. Oxidation Test (D - 943 - 47T) with the same base oil, untreated and treated with an oxidation inhibitor.**

| | Uninhibited hydraulic oil | Same oil containing oxidation inhibitor |
|---|---|---|
| Neut. No. (original) | .056 | .056 |
| After 250 hrs. | 2.0 plus | .24 |
| After 500 hrs. | — | .85 |
| After 1000 hrs. | — | 1.0 |
| Naptha Insolubles | | |
| After 250 hrs. | 81 mg. | 1.2 mg. |
| After 500 hrs. | too heavy to filter | 7.4 |
| After 1000 hrs. | — | 9.8 |
| Viscosity @ 100F (SSU) | | |
| Original | 161 sec. | 161 sec. |
| After 500 hrs. | 501 sec. | 170 sec. |
| Final (1000 hrs.) | * | 184.5 sec. |
| Percent Increase | 272 % (500 hrs.) | 14.5 % (1000 hrs.) |

* Test on uninhibited oil discontinued after 500 hrs. because oil was badly broken down.

**Fig. 5. Steel rods after test runs at the A.S.T.M. Rust Test (D-655-42T). The left two rods were run in a rust inhibited oil; right, two rods in an unihibited oil.**



# PRESSURE ACTUATED

**A clarification of the elements that go into the design and application of pressure actuated switches; and suggestions for the use of functional schematic symbols for circuit detailing and specification purposes.**

By GEORGE A. STARBIRD

PRESSURE ACTUATED SWITCHES deserve much more attention and study in the future than they have in the past. Today, almost every modern machine depends on some changes in pressure to perform some operation. Hydraulic brakes on our automobiles are operated by change in pressure. The manufacture of precision machine parts is often accomplished by hydraulic pressure change.

Inasmuch as it is impossible to determine visually the pressures that exist internally in the various hydraulic components, some method had to be developed to sense this change. Many years ago the Bourdon type pressure gauge was developed to visually inspect the pressure within boilers and tanks.

With the advent of semi-automatic and automatic machinery, some method had to be developed to translate the changes in pressure to changes in electric currents. This electrical energy can then be utilized to operate motors, solenoid valves, warning lights or any desirable equipment.

Far too often in the past, engineers in designing equipment, frequently very complex, have desired to operate it with a pressure actuated switch and have left the selection of the proper switch to the last moment. At this stage of the project many accumulated errors must be absorbed and the pressure switch is not always the component best suited for this absorption.

ABSOLUTE PRESSURE. The force or pull of gravity, approximately 14.7 psi on the atmosphere at sea level.

ACCURACY. The abilty of any given pressure actuated switch to consistently repeat its operation within the limits specified.

ACTUATION VALUE. The pressure difference required to complete the actuation and reactuation cycle of a pressure actuated switch.

ADJUSTABLE RANGE. Pressure range within which the actuation value of a pressure actuated switch may optionally be fixed.

AMBIENT PRESSURE. Adjacent barometric pressure, not necessarily atmospheric, immediately surrounding and influencing an uncompensated pressure actuated switch.

ATMOSPHERIC PRESSURE. Pressure of the atmosphere at any level measured by a barometer.

GAUGE PRESSURE. An indicated pressure on an unspecified gauge. Gauge pressures, generally, are assumed to be barometric in terms of psi above atmospheric pressure at sea level.

IMPEDANCE. In hydraulics, the pressure drop resulting from frictional loss and inertia.

PROOF (WARRANTY) PRESSURE. The maximum pressure a pressure actuated switch will withstand without affecting its specified accuracy.

# SWITCHES

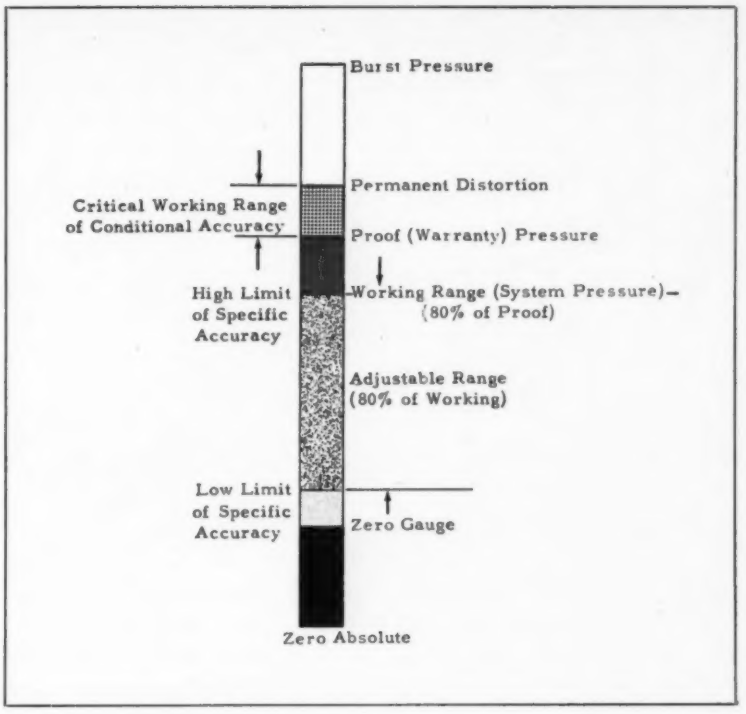



**Fig. 1. A vertical scale representation of pressure increments significant in the functioning of pressure actuated switches.**

When control is to be accomplished by changes in pressure, these changes must be analyzed carefully and the switch must be selected with the same analytical thought that is employed to choose important instruments. It is believed that the information contained in the following pages will be of great value to designers and users of pressure actuated switches.

REAL PRESSURE. The difference between two specific pressures expressed as a numerical value.

REFERENCE PRESSURE. Any reference established by specification for fixing the requirements of a pressure actuated switch; may be absolute, controlled or ambient pressure.

SPECIFIC PRESSURE. Any stated pressure with limits established by specification.

STATIC PRESSURE (HYDRAULIC). Potential energy in stationary fluids, usually expressed in terms of a reference pressure.

SURGE. A transient pressure, usually unpredictable in magnitude or regularity.

TOLERANCE (MANUFACTURING). Relative accuracy of two or more pressure actuated switches within the limits specified.

VACUUM. A pressure less than that of the atmosphere.

VARIABLE PRESSURE. A predictable transient pressure having characteristics of sufficient magnitude to actuate a pressure actuated switch.

WORKING RANGE (SYSTEM PRESSURE) Maximum pressure potential of a system, or 80 percent of the proof pressure of a pressure actuated switch.

The primary purpose of this article is the establishment of a standard nomenclature for exchanging specific pressure actuated switch information between the manufacturer and the client. If it succeeds in narrowing the range of many terms so variously and widely applied as to be almost useless to the engineer, it will have justified the effort. If a designer or plant engineer presented with a problem requiring a pressure actuated switch is assisted to an earlier solution, he will feel well repaid for his reading effort.

In considering the use of pressure actuated switches, it should be remembered first and foremost that they are basically pressure instrument mechanisms of precision quality. They utilize electrical switches only for translating pressure change into electrical control, much as a pressure gauge translates pressure change into visual increments.

Semi or fully automatic control of many modern machines is made possible by the use of liquid or gas under pressure which changes in direct relation to the required operating

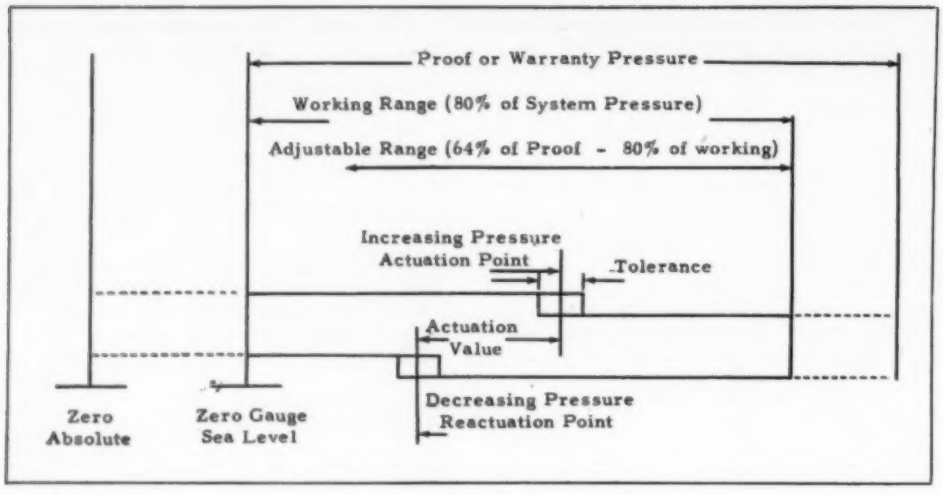



**Fig. 2. A horizontal scale showing the schematic relation of adjustable range to working range and proof or warranty pressure and the relation of pressure change (increase or decrease) to actuation of a pressure actuated switch.**

cycle. The pressure actuated switch is capable of sensing and signaling the instant critical pressure occurs. Relays, solenoid valves, visual or audible signals are made to respond to changes in the electrical circuits produced by pressure actuated switches.

### Correct Reference Pressure Must Be Used

An interesting practical condition arose recently in a meat market. For some years the market was able to maintain the proper humidity in the meat counter so that the products were sold for a profitable price. The market was air conditioned, and the meat department no longer seemed to be able to operate on a profitable basis. After considerable research, it was discovered that the pressure switch used to control the refrigeration cycle was based on the reference pressure of the normal atmospheric air. The air conditioning system supercharged the market to such an extent that the refrigeration cycle, which in this case was really a humidity cycle, was so altered that the meat became dehydrated to such an extent that the shrinkage reduced the gross income. This is an actual but isolated example of what can occur when a person is not conversant with pressure actuated switches and their problems.

A businesman, or his technical agent, presented with pressure switch problems naturally turns to a pressure switch designer for solution, because the nomenclature pertaining to these items has not been clearly defined.

The abridged definitions of some confusing terms, commonly used in preliminary discussions, are listed in the accompanying box. The definitions are designed expressly for pressure switch application, without any intent to conflict with their accepted usage in other engineering fields. Electrical nomenclature has been purposely omitted, as common usage of existing terms meets the general communication requirements of pressure actuated switches.

It is not intended to present a short course in hydraulic engineering, nor to dwell on definitions or terms readily found in standard references, if their application to pressure actuated switches needs no further clarification. The remarks that follow should be considered more in the light of practical applications, summary or supplement for the designer or plant engineer whose normal assignments are outside the specialized field of closed system hydraulics.

### Significant Points on Pressure Scale

Perhaps the best way to clarify some of the terms describing a pressure actuated switch is to consider a pressure gradient beginning at zero absolute and rising to the burst point (point of destruction) of the instrument. Figure 1 represents such a scale, ascending from absolute zero, a theoretical reference. The first increment of importance is sea level pressure. This is the most commonly used reference for gauge pressures.

The next increment of importance is the working range of the instrument. This is also the greatest system working pressure, including surge peaks or other high (however instantaneous) pressures.

Proof or warranty pressure is the next important increment. This is the limit of the instrument's ability to maintain specified accuracy.

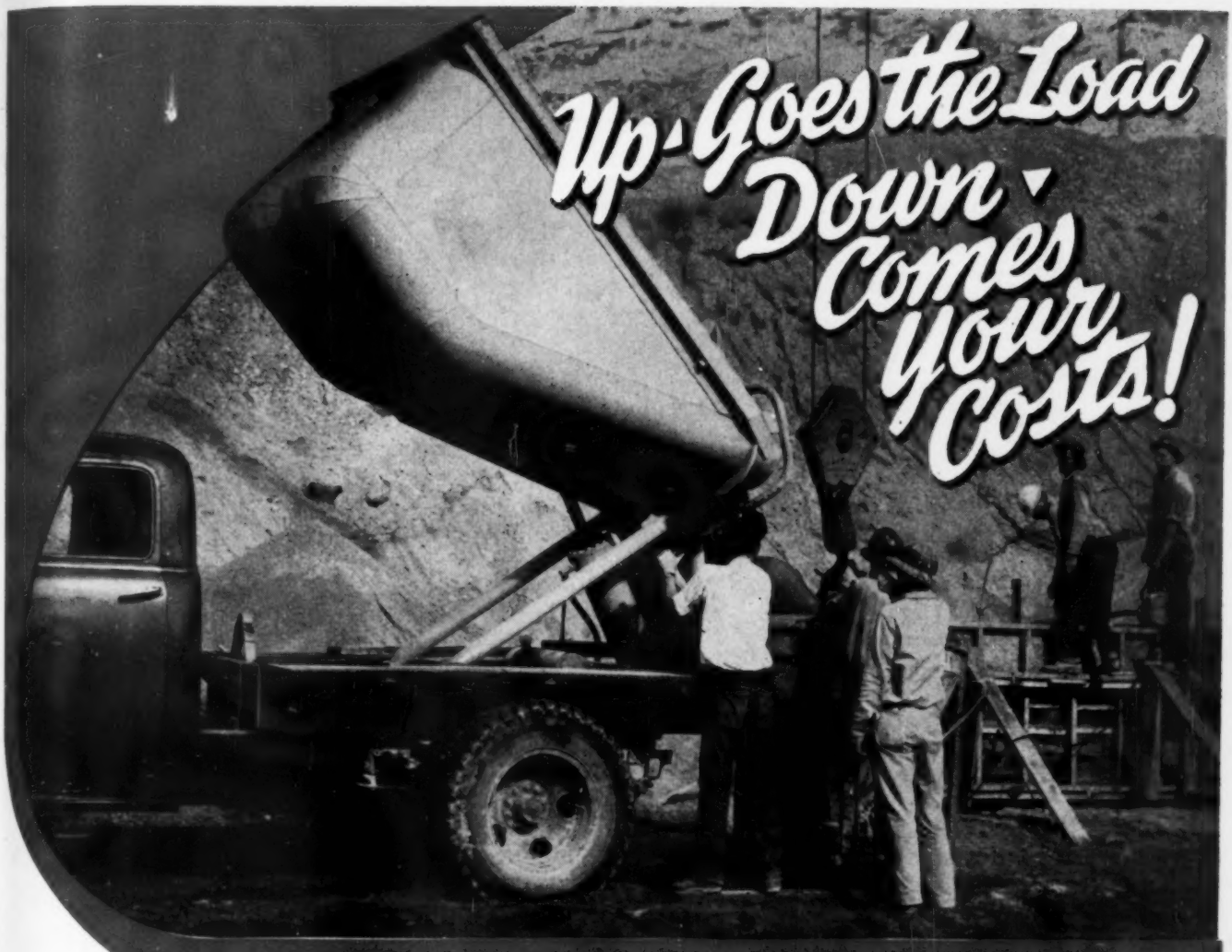
Next is the level of permanent distortion, where the sensitive member of the mechanism has been strained beyond its ability to return to normal accuracy without readjustment.

Finally, at the top, is the burst pressure point, or pressure where injury to the instrument is so complete as to render it useless.

Descending the scale, the value between permanent distortion and warranty pressure is a critical working range of conditional accuracy. Hysteresis effect, induced lag and other phenomena are present in greater or lesser degree. The time required for the instrument to return to normal accuracy is greater as the point of permanent distortion is approached.

The pressure value between the working range and proof pressure point (80 percent of the proof pressure) is the manufacturer's margin of warranty safety, insuring guaranteed specific accuracy. The adjustable range begins at the working range and extends downward 80 percent of that range. This establishes the low limit of warranted accuracy.

*Part II treats pressure factors and instruments and gives details on recommended diagrams and schematic symbols for pressure actuated switches.*

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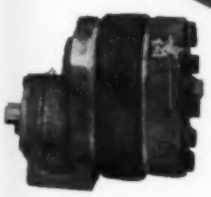

*Single Type 2" Gear Pump Pedestal Mounting — 20 G.P.M. Capacity.*

*3/4" Tandem Type Valve Single Acting with Relief Valve.*

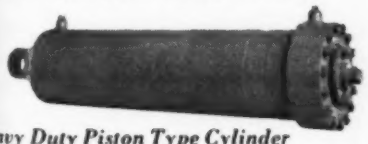

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Fig. 1. All the controls and gauges for the new Contour-matic are conveniently grouped. The operator is making a speed change by turning the speed change dial.

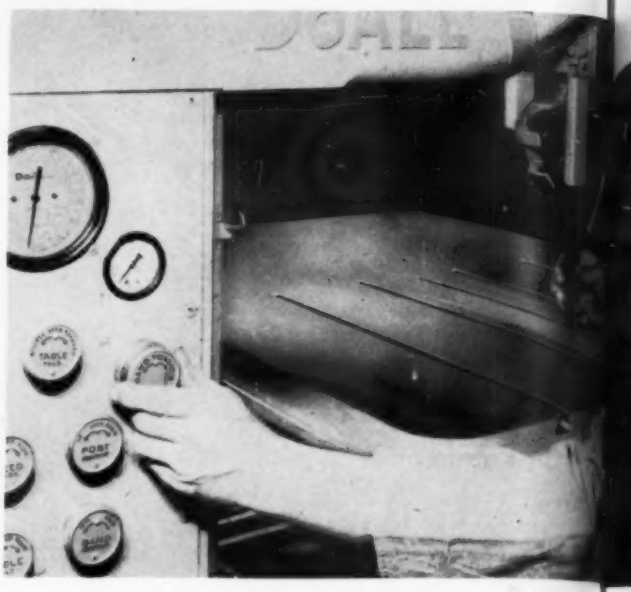

Fig. 2. Band or blade tension, set by a dial movement by the operator, is controlled by a four-way valve which operates the band tension cylinder which vertically adjusts the spindle assembly of the upper band wheel.

# THE CONTOUR MACHINE – A HYDRAULIC GRADUATE

**The incorporation of hydraulic power and control for many functions performed by a contour machine has added advantages which mean increased production and cost cutting.**

THE MANUFACTURING INDUSTRY has learned that where its workers have to make many decisions or perform repetitive motions, the results are seldom uniform and resulting production costs are high. This is one of two major reasons why working tools that reduce or eliminate human errors are used in increasing numbers throughout industry. The other reason, of course, is to increase production or to decrease unit cost.

The contour saw for the band sawing of metals is one of the newest tools used by the metal working industry. Like other metal working tools, it was introduced as a hand operated machine that emphasized the cutting tool to be used. Because skilled operators were required, operators conversant with hand feeding techniques as well as adept in the use of special fixtures and attachments, it was natural that the contour saw or machine became a favorite in the tool and die shop where such skills are found.

Manufacturing production machines, as distinguished from standard machine tools by design features and operational characteristics, basically must permit fast, efficient semi-automatic or automatic operation by comparatively unskilled operators. As the contour machines, because of their versatility, began to be introduced for high production work, it was evident that the best utilization of their advantages as production equipment required keeping in step with automation.

Logically, the first hydraulic operation introduced was that of an auxiliary unit—a work feed table.

Then, in one broad sweep, hydraulic power was applied to the newest contour machine—the Contour-matic—making it the first such machine to employ hydraulic power and control throughout its operation.

The entire operation of the ma-

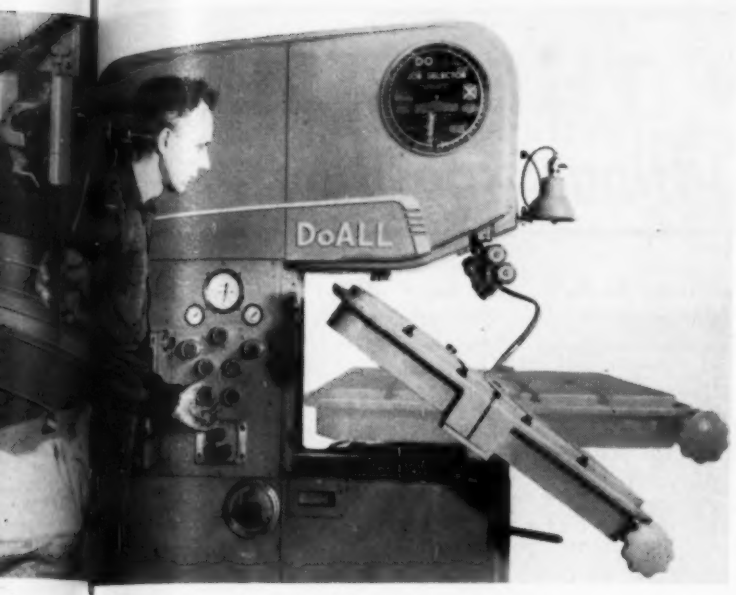


**Fig. 3. Hydraulic table tilt, also dial operated, is accomplished by the table tilt cylinder (see Figure 4), controlled by the four-way tilt valve. The table is shown tilted to its maximum right position of 45 degrees.**

chine is hydraulic. The only exception is the use of a three-speed transmission and a variable pitch diameter sheave assembly and this unit is controlled hydraulically.

The central control panel, shown in Figures 1, 2 and 3, has three gauge type dials and seven operating dials. The large top gauge is the speed indicator, the smaller (left and below) tension. Immediately below the large gauge is the table feed dial, to its left is the table feed pressure dial and to its right the band tension dial. The operator in Figue 1 is shown making an adjustment in the speed change dial. This actuates a 1¾ in dia cylinder. To the right of this dial is the post adjustment dial, which, in its neutral position, locks a 2½ in dia cylinder. The bottom left dial operates the table tilt and the bottom right dial the on or off band adjustment.

The operations which are hydraulic include blade tension and automatic brakes, table pressure and feed, table tilt and speed variation control.

An internal gear type pump of 3 gpm capacity is used. Separate four-way valves are provided for speed change, post adjustment, table tilt and band adjustment. Adjustable relief valves control table feed pressure and saw band tension.

### Tension Control

The upper tool carrying wheel, interchangeable with the lower wheel, is mounted on a bearing spindle. This assembly is actuated by a 3 in dia band tension cylinder. A built-in accumulator in this circuit maintains a small amount of tension on the band for several hours, preventing the band from going slack for setups or adjustments with the power off. The band tension dial, see Figure 2, actuates the band tension relief valve to operate this cylinder.

The feed rate is controlled by pressure against the saw blade. Pressure is adjustable to suit different blade widths and work heights. Pressure control is accomplished by dial movement to operate the feed pressure relief valve. This valve operates in conjunction with the four-way valve that controls table movement. The four-way valve permits a feed control rate independent of or com-

*(Continued on page 44)*

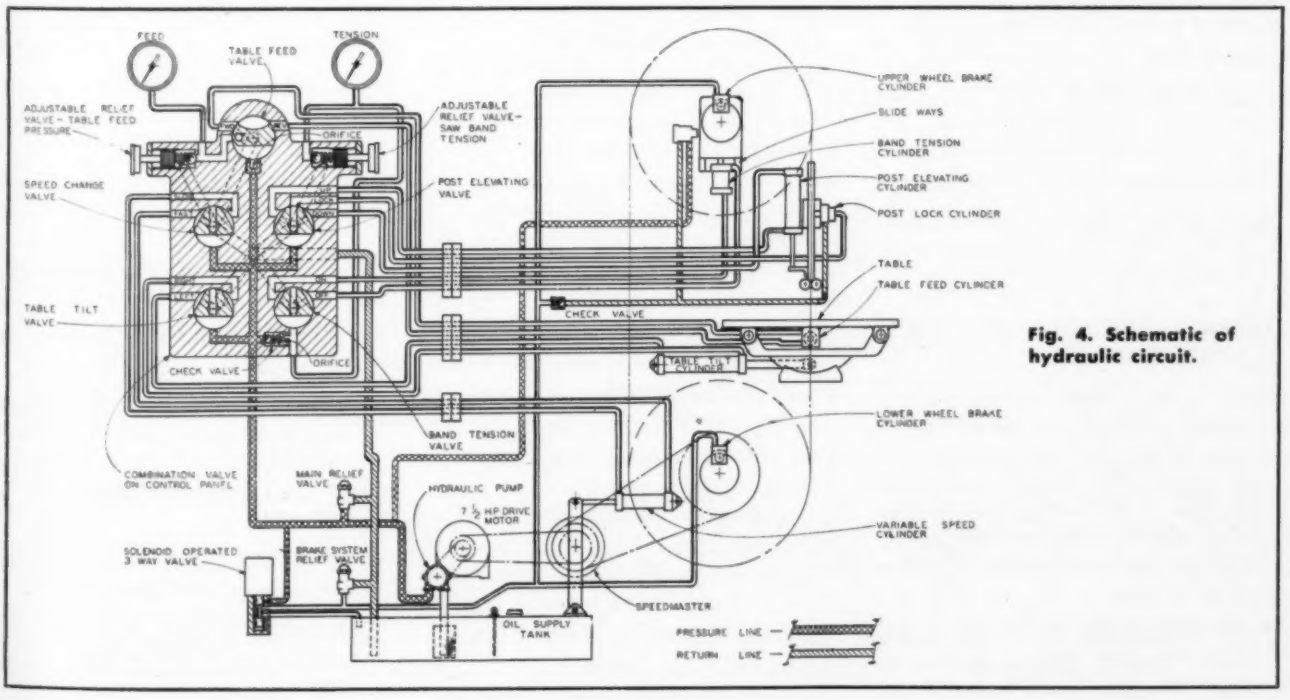


**Fig. 4. Schematic of hydraulic circuit.**

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### Automation

Automation, the newly coined word that will be so evident at the cost-cutting meetings, isn't found in Webster yet. The word is derived from automaton, meaning a thing capable of spontaneous motion or action. Automation is used to describe the process of converting manual to automatic, with the twin objectives of reducing cost and the amount of physical labor required from the worker.

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**Booth 951**

*YOU WILL SEE:* Air operated oil hydraulic presses.

*YOU WILL MEET:* L. R. Beck; P. L. Reynolds.

### LOGAN ENGINEERING CO.
**Booth 1045**

### LOGANSPORT MACHINE CO., INCORPORATED
**Booth 707**

*YOU WILL SEE:* Hydraulic valves; cylinders; power units; air valves; air cylinders; air-draulic cylinders; moving displays featuring air cylinders and air-draulic cylinders; hydraulic presses; coolant pumps.

*YOU WILL MEET:* L. R. Burger, sales manager; W. A. Smith, service engineer.

### M-B PRODUCTS
**Booth 642**

*YOU WILL SEE:* New automatic air line filter, regulator and lubricator assembly; new air pressure ducing and regulating valves; automatic air line filters; automatic air line lubricators; portable pneumatic grinders.

*YOU WILL MEET:* I. Manheim; G. Harwood.

### MICRO SWITCH
**Booth 557**

*YOU WILL SEE:* New subminiature snap-action switch; new small double-pole, double-throw switch; new hermetically sealed switch; new door interlock switches.

*YOU WILL MEET:* J. K. Lincoln, K. J. Cumming, G. G. Boyle; J. A. Thoerle.

### MILLER MOTOR COMPANY
**Booth 735**

*YOU WILL SEE:* Operating exhibits of high-pressure hydraulic cylinders demonstrated with a low friction test set up; leakproof water bubble test and low friction leakproof test to demonstrate air cylinders; hydraulically controlled air power; fluid pressure boosters.

## Word "Automation" in Title of Four Papers

Four of the papers to be delivered at the ASTE meetings during the Cost-cutting Exposition have "Automation" in their titles. This word fully describes a definite trend in industry. This trend is to make manufacturing machines produce faster at a lower cost at less operator effort through automatic operation. It is not new thinking in industry but is rapidly becoming the practice because of the changing times and conditions. Some authorities foresee in the not distant future the replacement of the non-skilled man who will lose his job to a machine, however they also predict that through "Automation" new horizons and new jobs will be open to him. Manufacturing machines that produce faster at a lower cost and at less operator effort will have a good effect for the average man because they will allow him to have more of the products of industry and will give him more time to enjoy them.

*YOU WILL MEET:* F. Flick, chief engineer; J. L. Modrich, sales manager; L. Menken, advertising manager; and sales representatives.

### MODERNAIR CORP.
**Booth 957**

*YOU WILL SEE:* New CV series valves; control valves for air and hydraulic circuits; air operated machine tool feeding units; nonrotating cylinders; air presses; air collet closing fixtures; air operated hydraulic pumping units; quick exhausting valves.

*YOU WILL MEET:* J. E. Goldring, president; D. E. Daniel, vice president; G. L. Sanderson, Eastern representative.

### C. A. NORGREN CO.
**Booth 635**

*YOU WILL SEE:* New reversible lubricator; new filter-regulator unit; relief valves; needle valves; lubro-control units; air filters; pressure regulators; filter-regulator units; hose assemblies and accessories.

*YOU WILL MEET:* J. M. Evans, sales manager; D. G. Faust, chief engineer; C. N. McDavitt, district sales representative.

### THE ORTMAN-MILLER MACHINE CO.
**Booth 110**

*YOU WILL SEE:* Air and hydraulic cylinders; combination units.

*YOU WILL MEET:* N. H. Ortman; C. G. Gilmore.

### RACINE TOOL & MACHINE COMPANY
**Booth 222**

*YOU WILL SEE:* Variable volume pumps; balanced piston sleeve type valves; pressure boosters.

*YOU WILL MEET:* J. E. Erskine, secretary; H. A. Schultz, sales manager; G. B. Miller, chief hydraulic engineer; J. B. Anderson, hydraulic engineer.

*Courtesy Greer Hydraulics, Inc.*

**RIVETT LATHE & GRINDER INC.**
**Booth 1020**

*YOU WILL SEE:* Hydraulic power units; hydraulic intensifiers; hydraulic cylinders; hydraulic valves; air cylinders; air valves.

*YOU WILL MEET:* A. B. Hunt, treasurer; J. A. Marsh, sales manager; A. E. Kempton, chief engineer; D. Newhall, president, Harwood Engineering; J. J. O'Brien, E. B. Keeler, representatives.

**Ideas**

*Submit your labor-saving, cost-cutting ideas to the "Here's How" editor. Ideas that you have found useful and might be of value to others. A brief note or sketch will do—we will dress it up. $5.00 will be paid for each article published with $10.00 going to the one considered best for the month.*

**ROSS OPERATING VALVE COMPANY**
**Booth 139**

*YOU WILL SEE:* Hand, foot, solenoid, remote controlled and mechanical operating valves; straightway, speed control and special purpose valves.

*YOU WILL MEET:* J. Sainsbury, president; R. J. Cameron, vice president and sales manager; F. W. Hicks, chief engineer; J. Rowe, plant manager; and sales engineers.

**A. SCHRADER'S SON**
**(Div. Scovill Mfg. Co. Inc.)**
**Booth 752**

*YOU WILL SEE:* New series of single and double acting cylinders; two new models of air clamps; new automatic quick exhaust valves; five new sliding seal valves; new four-way diaphragm type hand valves; new cutout valve; new air exhaust muffler; new automatic air line lubricator; new air filter; new rotating pressure joints; hydrodial gauges; hand ferrule contacting tool.

*SPECIAL ACTIVITIES:* Operating displays of air injection sets, pneumatic controls, couplers, pressure regulators, cylinders and valves.

**SCHRAMM INC.**
**Booth 1132**

*YOU WILL SEE:* Stationary V-belt-drive compressors.

*YOU WILL MEET:* L. B. Schramm; J. E. McGrogan; G. B. Comfort; A. O. Witt.

**SHELL OIL COMPANY, INC.**
**Booth 922**

**SPERRY PRODUCTS, INC.**
**Booth 13**

**STANDARD PRESSED STEEL CO.**
**Booth 128**

*YOU WILL SEE:* New Hallowell "Carry Tool" tool toter; new steel posture stools; new steel foreman's desks; new "700" steel platform trucks; Unbrako socket screw products; Flexloc self locking nuts; Hallowell steel shaft collars; steel work benches.

*YOU WILL MEET:* J. W. Friel, general sales manager; C. W. Hollingsworth, Unbrako sales manager; J. J. Wiest, Flexloc sales manager; H. T. Hallowell Jr., vice president and general manager; and other sales and engineering personnel.

**SUN OIL COMPANY**
**Booth 717**

*YOU WILL SEE:* Sunicut straight transparent cutting oils; Sunoco emulsifying cutting oil; Sun quenching oils; Sun rolling oils.

*YOU WILL MEET:* A. B. Myler; R. S. Drysdale; M. A. Markley; H. B. Price, Jr.; S. W. Craig; I. E. Owens.

**SUNDSTRAND MACHINE TOOL CO.**
**Booth 907**

*YOU WILL SEE:* Operating exhibit of pumps, valves, fluid motors, tank units.

*YOU WILL MEET:* W. Staublin; O. E. Mayfield; P. Anderson; R. J. Murphy; B. Lundgren; H. Wahlmark.

Magnetic and Pneumatic Divisions will also be represented.

**THE TEXAS COMPANY**
**Booth 512**

*YOU WILL SEE:* New cutting coolants; hydraulic oils.

*YOU WILL MEET:* J. J. Clark, chief engineer; H. E. Ennis, supervising engineer; J. C. Kindig, R. A. Howard, cutting oil engineers; G. S. Huntington, K. E. Blanchard, lubricating engineers; cutting oil engineers and industrial salesmen.

**THE TOMKINS-JOHNSON CO.**
**Booths 971, 972**

*YOU WILL SEE:* T-J hydraulic cylinders; air cylinders; rivitors; clinchers; arbor presses.

*YOU WILL MEET:* A. R. Johnson, president; D. J. Elder, general manager; J. R. Elder, superintendent; W. J. Remund, sales manager; G. B. Cranor, chief engineer; A. Reichert, advertising manager.

**TRABON ENGINEERING CORP.**
**Booth 1116**

*YOU WILL SEE:* Motor-driven KA pump dispensing oil; Motor-driven MP pump dispensing grease through proportioning valve (plastic, for visual inspection); motor-driven 3400 pump dispensing grease through type M distributing system; KM manual pump, reversible system. All units will be in operation.

*YOU WILL MEET:* L. W. Deutsch, sales manager; Charles O. Anthony; Dale Penz; Henry Droneberg; Robert McCreary; R. H. Nielson; Felix Wengert; Gerald A. Hays.

**UNION MANUFACTURING COMPANY**
**Booth 650**

*YOU WILL SEE:* New Unaloy ultra precision die sets; new bi-metal chucks, both hand and air operated; new ultra precision scroll chuck; new power wrenches.

*YOU WILL MEET:* W. F. Skillin, president; G. V. Murhpy, N. Y. sales manager, G. E. Van Wert, superintendent; C. A. Bedford, chief engineer; and sales representatives.

**U. S. DEPARTMENT OF COMMERCE**
**Booths 39, 40**

*YOU WILL MEET:* Representatives of the Office of International Trade, the Office of Domestic Commerce and ECA. Data on the type and quantity of machinery and allied products currently being sought by foreign countries will be available with information for foreign visitors on the handling of equipment purchases for export.

**VICKERS INCORPORATED**
**Booth 239**

**THE WEATHERHEAD COMPANY**
**Booth 1041**

# AVIATION HYDRAULICS

MAINTENANCE
DESIGN
OPERATION

**FRED O. HOSTERMAN**
**Advisory Editor**

# The Development of Hydraulic Power Steering of Airplane Nose Wheels

**By DON W. DRISKEL**
**Chief Engineer**
**Haskel Engineering & Supply Co.**
**Glendale, California**

WITH THE ADVENT OF LARGE four engined tricycle gear aircraft in the late 1930's, it became evident that a better means of directional control while on the ground would be necessary. Up until that time the use of differential braking had been adequate, but larger demands on brakes for stopping the airplane due to greater masses and higher landing speeds, plus the necessity for easier and more precise control, made the steerable nose wheel the most obvious answer.

Early installations at Douglas and Lockheed, outgrowths of direct manual steering previously employed on lighter ariplanes, further proved that brake wear and servicing could be greatly reduced and ground control greatly improved by the use of power nose wheel steering. The selection of hydraulic power for the steering medium seemed to be a natural choice, since hydraulic shimmy dampers were in wide use and such a device would still be necessary to damp the free castering nose wheel when it was not being steered.

The very first attempts at hydraulic power steering consisted of controlling an actuating cylinder attached to the nose wheel by means of valves in the cockpit operated by the pilot's feet. The valves, similar to power brake valves, applied pressure to the cylinder in relation to pedal displacement and load on the pedal. This method, however, did not prove satisfactory for the reason that a given angle of steering was not obtainable for a given load or deflection of the pedal. The torque about the shock strut centerline would vary considerably with wheel load and runway surface conditions. The pilot therefore had no idea of the direction of the wheel with relation to the airplane and could very easily turn the airplane sharp enough to ground loop without being fully aware of the condition until it was too late. It was apparent that a follow-up or phasing device between the control and the nose wheel would be necessary. In addition it was soon evident that better control could be attained if a greater ratio between control movement and wheel movement was provided. This was naturally limited by the foot pedal travel; however, by using a small steering wheel and rotating it more than one revolution, larger ratios would be obtainable. Ratios of six and eight to one resulted in less sensitivity and improved increment control.

Since steering was to be a selective operation by the pilot intended only to turn the airplane in congested areas at relatively low ground speeds, provisions were made to allow the wheel to free caster, but restricted from shimmy, i.e., the wheel turns or trails as dictated by the direction of the airplane, but is restricted by the flow of oil through the damping orifices. A thermal compensating accumulator to provide for temperature changes of at least 200 F in the damping circuit was also necessary. Figure 1 indicates functionally this final system which is still in use today on such airplanes as the DC-6 and Constellation.

The follow-up systems between the nose wheel and the control used in these early installations were of several types; however, the cable

and pulley system was the most commonly used. Push-pull rods, torque shafts and bell cranks or combinations of all these have since been used successfully. Two prime requisites for any follow-up system been determined to be low friction and minimum deflections. The oversight of either or both of these characteristics will very likely cause a system to overcontrol or seem to hunt and it will be impossible to steer a straight or predetermined course. This is especially true as the ground speed increases. The differential mechanism to provide for movement of the steering valve from either the nose wheel or the control wheel end may be accomplished by any one of several means. Probably the most simple type is a lever and pulley arrangement similar to that shown in Figure 1.

With the introduction of jet propelled aircraft, power steering of the nose wheel became an even more desirable feature. The low thrust developed by a jet engine at low ground speeds made the use of differential braking, an undesirable method for directional control. However, it was apparent that a much more compact installation, preferably one that incorporated all of the required hydraulic and mechanical mechanisms into one package unit, would be necessary. Considerable savings in installation and servicing time could be realized if this were done. In addition, the space available for installation of a steering mechanism on most military airplanes made a small, compact package unit mandatory.

One of the first such installations, on the North American B-45 four engined jet bomber, resulted in the unit shown by Figure 2. This 'steer damper' assembly was of a linear or straight line motion type, operating at approximately 3000 psi hydraulic pressure and installed on the airplane with the axis of motion parallel to the nose shock strut. One end was fastened to the landing gear fulcrum, the other to a bell crank with universal bearings transmitting the motion to a torque about the strut axis. A push-pull rod, torque shaft control between the damper itself and the cockpit was provided. The control wheel in this case was the aileron wheel, with the steering power selected by a button on the wheel and automatically disconnected when the airplane left the ground. This arrangement added the minimum to an already crowded cockpit.

By installing the damper so that the piston rod remained stationary and the damper body moved, the follow-up control was accomplished very simply. When not being used for steering, the unit was a self contained shimmy damping device with

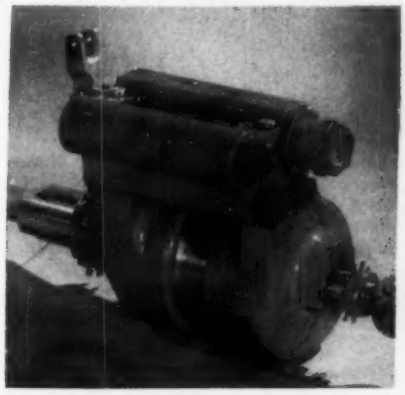


**Fig. 2. Linear type steer damper package unit as used on the North American B-45, develops thrust load of 26,500 pounds at 3,000 psi, hydraulic pressure.**

valves at both the inlet and outlet ports to block off the oil inside the damper. A small accumulator to provide for thermal changes and small external leakages insured adequate

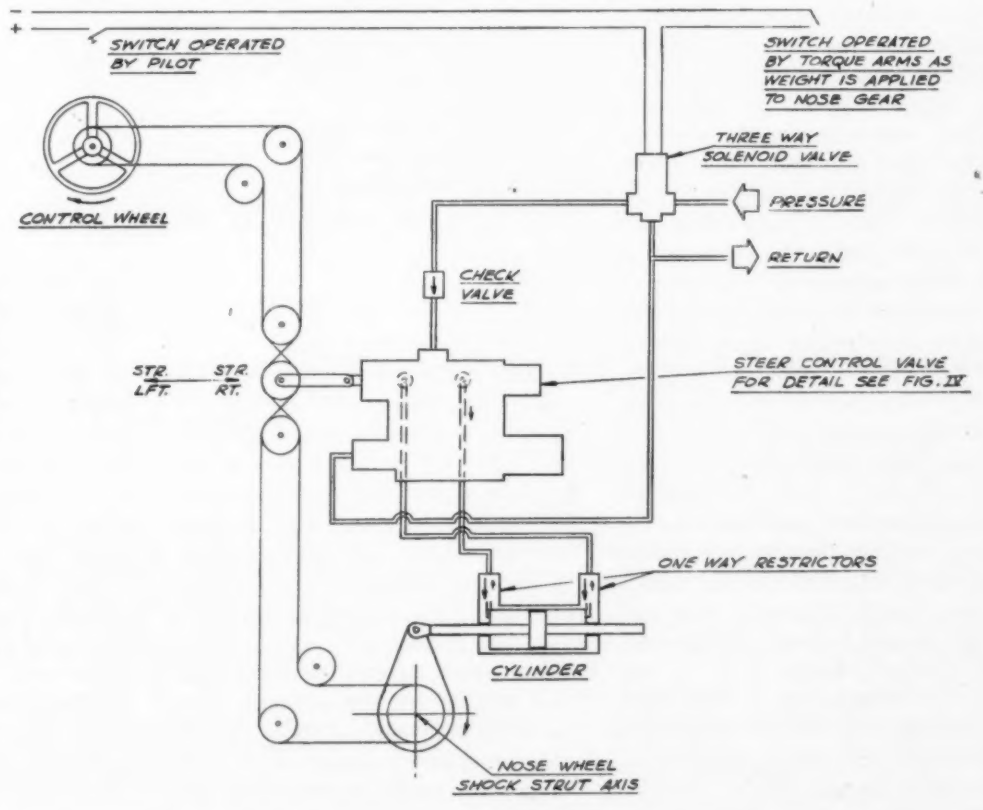



**Fig. 1. Functional diagram of early nose wheel steering system, similar to that still used on Lockheed Constellation and the Douglas DC-5.**

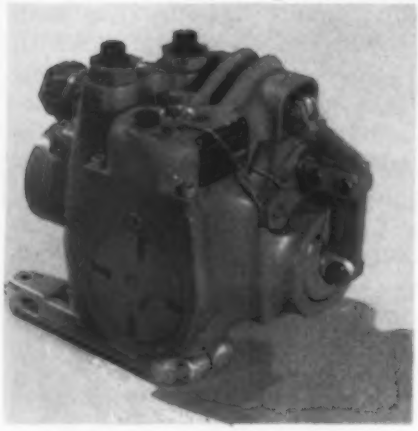


**Fig. 3. Rotary type steer damper package unit as used on the North American F-86, incorporates power actuator, shimmy restrictors, steering valve, pressure clutch, reserve oil chamber and follow-up linkage in one assembly.**

damping under all climatic conditions. This damping system oil was automatically replaced whenever the unit was steered by hydraulic power.

Further development of a packaged steering device came on the North American F-86 jet fighter. Here the linear straight line motion actuator was not suitable to the space requirements of the airplane. A small rotary type damper was the only design feasible. The unit finally arrived at is shown by Figure 3.

First installations of units on the airplane, however, uncovered several problems that had not been encountered on previous installations. The first resulted from the fact that steering was being controlled with rudder pedal operation. This meant that the total travel available to turn the nose wheel full hard left to full hard right, some 55 degrees, was only about six inches. In addition the nose-main wheelbase was lower than on any airplane where steering had been used previously. This meant that a given degree of steering angle had a much greater effect on the airplane directionally. It was also apparent that not enough consideration had been given to the installation of the control system between the damper and the rudder pedals. Space limitations had dictated the use of small, springy control members. Under these circumstances, the metering or feeling out of the steering usually done when controlled by a wheel did not provide good control.

Meanwhile pilots, familiar with steering in other airplanes, were using power steering to hold the airplane on course in crosswind takeoffs and landings. Considerable reduction in takeoff distance resulted from using power steering in place of dragging one brake. In addition, several bad crashes had been averted by applying steering power to compensate for blown main wheel tires when landing. This meant that the demands on this steering system were much greater than heretofore experienced but the operating conditions were on the adverse side.

The first step was to redesign the steer damper to lower the operating loads and reduce the necessary lost motion to the absolute minimum. By revising the control valve to provide operation wtih the very minimum amount of travel, reducing the overlap or dead spot in the neutral range plus reducing the valve operating loads, the total reversibility of the steering unit was lowered to between one and two degrees for steering left to right. At the same time a general beef up of the control system in the airplane was made. Hydraulic system pressure to the steer damper was reduced to a value just sufficient to steer the airplane. Also, the rate of steering was limited to not more than 15 degrees per second. These values were determined by actual taxi testing on the airplane. The final outcome was a steering system that adequately controlled the airplane at speeds approaching 100 mph.

Some of the more interesting recent developments on steering units include high and low speed selective steering, differential steering and electrical control of the hydraulic power steering.

High and low speed selective steering is accomplished by having a pilot's selector to determine whether high ratio or low ratio on the control between the unit and the cockpit is used. For low speeds the control is such as to provide full nose wheel travel for full rudder pedal travel. At high speeds the full rudder pedal travel results in a reduced nose wheel travel of generally 5 to 10 degrees each way from neutral. This arrangement provides better control at high speeds thru an angle sufficient to maneuver the airplane, yet give full wheel travel for low speed taxiing in congested areas.

The so-called differential type steering provides similar control to the selective steering but without the necessity of selective effort by the pilot. This is accomplished by a differential mechanism in the control or follow-up mechanism that provides a high ratio in the neutral range and a low ratio in the full travel range. This means that the control wheel or rudder pedal will move say eight or ten times as far as the nose wheel for turns up to 5 or 10 degrees off center. Beyond this point the control wheel or rudder pedal moves one half as far as the nose wheel or even less. Early taxi

*(Continued on page 43)*

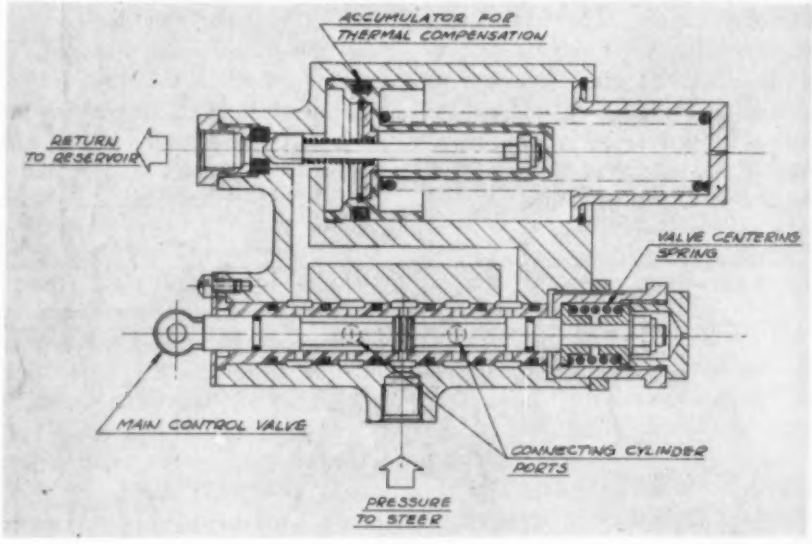



**Fig. 4. A typical steer control valve with integral oil reserve for thermal compensation when nose wheel free casters.**

# HERE'S HOW

- PREVENTIVE MAINTENANCE
- SERVICE PROCEDURES
- MODERNIZATION
- SHORT CUTS

## An Answer to 'Hydraulic Dashpot'

IN ATTEMPTING to answer a part of Mr. E. F. Heiser's question in the February issue of APPLIED HYDRAULICS ("Here's How", page 17), I would recommend that he try to standardize on a tapering plunger in a manner similar to Figure 1.

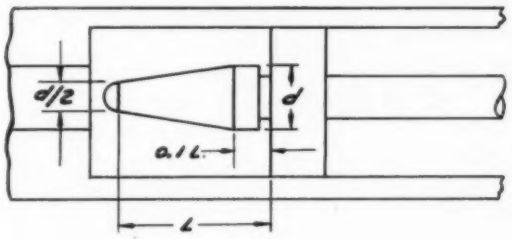



Fig. 1.

The diameter d may be approximated by assuming constant deceleration of the machine members and by including the work resulting from entering the dashpot under power (pressure against the other side of the piston). An average dashpot pressure, assumed to act over the distance L, may be established from this type of analysis, which will, of course, be lower than the peak pressures encountered during deceleration.

The plunger should be pointed to lessen the impact as it enters the dashpot. Pressures encountered during this transient period are difficult to predict, as the oil is compressed upon impact and pressure waves are set up that bounce off the end of the dashpot and the plunger. A small amount of experimentation, particularly if dashpot pressures are checked with a hydrauliscope, will greatly assist in arriving at a standard plunger.

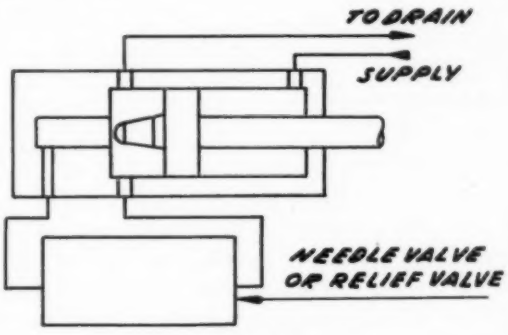



Fig. 2.

The following alternate methods may be used to modify the plunger action without filing. Figure 2 show a needle valve or relief valve built into the dashpot housing. A steel ball and spring should prove satisfactory as a relief valve for this service. The relief valve system offers advantages of a more nearly constant deceleration and an easier prediction of d and L.

The deceleration valves offers many advantages when a hydraulic cylinder is purchased without internal dashpots. It may be hooked up as shown in Figure 3.

The deceleration action of this system is similar to the dashpot. The advantages are: (1) greater flexibility; (2) lower deceleration pressures, due to the greater area of the

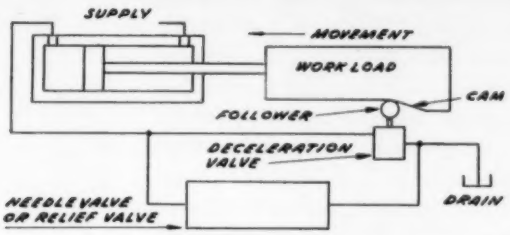



Fig. 3.

piston over that of the plunger; and (3) the external cam is easily modified. In fact, the external cam can be made adjustable and the system tried first without the by-passes in the line.

This system may be modified to provide a deceleration action proportional to the system pressure, as shown in Figure 4.

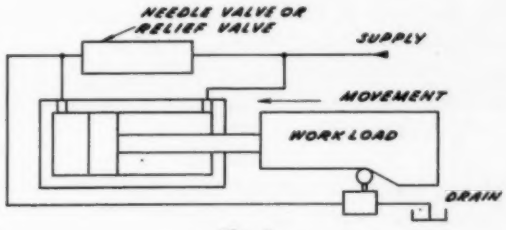



Fig. 4.

If only a pump is used, the supply pressure is relatively low when deceleration begins. However, the supply pressure starts to build up as the piston velocity drops. This creates a back pressure against the needle or relief valve, increasing the deceleration pressure. It will also tend to reduce and dampen out peak pressures developed during deceleration, particularly those due to vibrations of the piston along the centerline.

ROBERT L. HALL
177 Commonwealth Ave.
Cleveland 24, Ohio

## The Use of Air as a Trouble Shooter in Hydraulic Systems

AIR IN A hydraulic system is always a source of trouble. However, where pumps, valves and pipe lines are submerged in the oil reservoir, air can be used very effectively to locate trouble.

The procedure is quite simple. The oil is drained from the reservoir or low enough to be able to see all the units and lines. An ordinary shop air supply is connected to the pressure side of the system.

The air will find its way through very small openings in the form of bubbles, while oil will pass only at high pressure.

We have found that the air method will locate broken joints, welds, pipes or any openings in the system. This simple procedure has saved us many hours of hard work and worry.

GEORGE M. GEIGER,
362 W. High St.,
Mount Gilead, Ohio
H.P.M. Co.

# Theory and Application of Pneumatic Control Systems

By J. L. Dooley

PNEUMATIC CONTROL COVERS A very wide field. The old player piano, for example, is an early version of pneumatic control. The latest rocket motor test stands built in this country use pneumatics for remote operation, indication and recording extensively because of its simplicity and ruggedness; the latest high speed duplicating typewriters operate from punching holes in a paper ribbon by the use of low pressure compressed air.

The basic advantages of pneumatic control work are:

1. Compressed air is readily available.
2. The viscosity of the gas varies very little with temperature variation.
3. Only one small connecting tube is required to transmit an accurate signal.
4. There is no direct fire or shock hazard. Although air is not itself inflammable, it would, of course, support combustion.
5. Compressed air energy can be stored in reasonable quantity. The air receiver is the simplest, lightest, cheapest, most reliable and generally most compact means of storing energy in use today. All lines and incidental volume in the system become part of the receiver.
6. Rate of response is high because air has little inertia. The first impulse travels at the speed of sound; actual air for power is slower (200-300 feet per second).
7. Pneumatic equipment generally is simple so that average maintenance personnel can understand it and it is rugged enough for them to handle.
8. Rotary motors are light and rugged. They can be reversed easily and can stall indefinitely under load without damage.
9. Compressed air lends itself to linear motion by use of a cylinder and piston.
10. Being non-toxic, power air can be used for ventilation or cooling. (Expensive or wasteful.)
11. No danger or mess results when air is dumped in quantity.
12. Since it is compressible, air has cushioning characteristics.

As with every other means of transmitting power or a control signal, compressed air has its disadvantages. In general, these are:

1. The overall thermodynamic efficiency is low. (Often below 15 per cent.)
2. The compressibility of a gas causes difficulties in some applications. This is particularly true where positioning a cylinder is required.
3. Small leaks are difficult to locate, isolate and eliminate.
4. An explosion hazard exists wherever pressure vessels are used.
5. Components operated by compressed air, e.g., cylinders, valves and motors must be lubricated, since air in itself is not a lubricant.
6. Water vapor in compressed air must be properly controlled to prevent malfunctioning of equipment due to freezing.

In general, compressed air at any ratio of compression above 2:1 is obtained by a positive displacement compressor except in very high capacities, such as a gas turbine engine, where centrifugal or axial flow units are used. Above a ratio of compression of about 6:1 (75 psig or more), reciprocating piston type compressors are used almost exclusively.

The flow control of these machines illustrates many types of pneumatic control applicable to other equipment, and, for this reason, is reviewed in some detail:

*Mr. Dooley is director of research, Rhodes Lewis Co., Culver City, Calif. This resume of his paper, the second in a series, covers the second conference held by the Committee on Hydraulic and Pneumatic Systems. Brief reports will be made of these meetings each month.*

1. The inlet line may be closed or the inlet valves held shut, forcing the compressor to pull a vacuum on the inlet and thus reach its terminal compression ratio.
2. The discharge line may be closed with a check valve and the compressor discharge opened to atmosphere, permitting free flow through the compressor.
3. The inlet valves may be held open, permitting air to flow in and out with each stroke.
4. The rotative speed of the compressor may be changed or, if necessary, stopped.
5. The clearances in the compressor cylinder at top dead center may be increased to reduce the capacity. This may be done by opening ports or shortening the stroke.
6. The compressor air system may be designed to permit the compressor to reach terminal pressure at ratio of compression if ratio of compression is high enough to permit no flow.
7. The compressor may be allowed to run continuously and the discharge relieved to atmosphere at operating pressure.

Most of the above methods of control require some type of pressure sensing devices in the compressed air systems with a snap acting mechanism to apply air to and operate the unloading system indicated above. To date, the only practical method we have of measuring gas pressure is to balance this pressure, applied over a known area, against a weak structure, e.g., a spring, and then measure the deflection of this structural element.

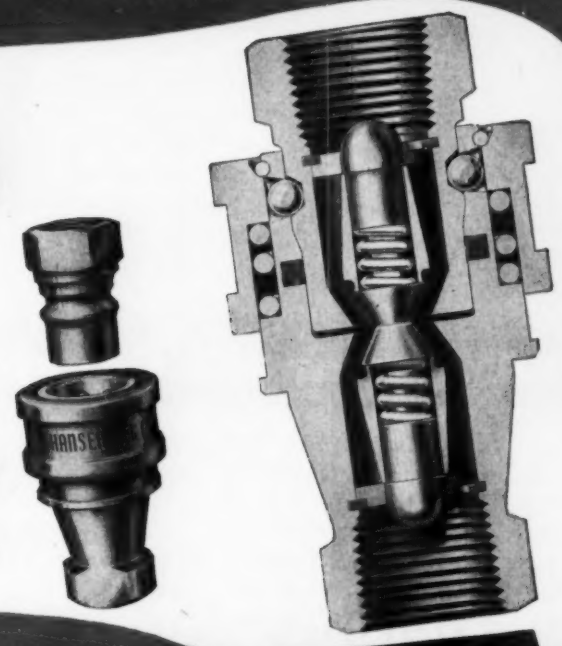
This is the basic plan behind every pressure regulator, gauge and other pressure controlling device except those with dead weights in place of the spring. This small deflection must be amplified to be usable. In a gauge this amplification is mechanical. In some types of pressure pickups the amplification is elec-

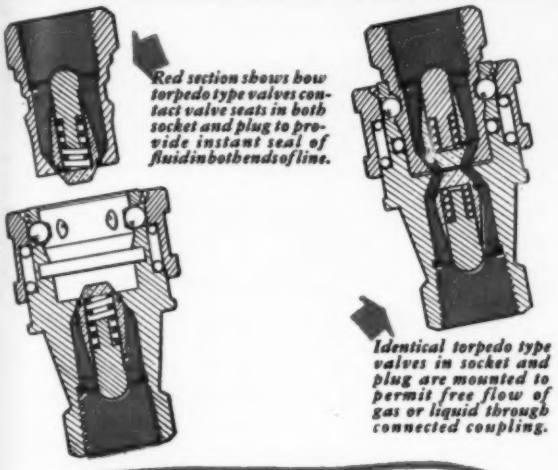
*(Continued on page 43)*

# "NEW" FOOLPROOF

# HANSEN

## HIGH PRESSURE 2 WAY SHUT-OFF COUPLINGS





*Red section shows how torpedo type valves contact valve seats in both socket and plug to provide instant seal of fluid in both ends of line.*

*Identical torpedo type valves in socket and plug are mounted to permit free flow of gas or liquid through connected coupling.*

## SEALS BOTH ENDS OF LINE AUTOMATICALLY INSTANTANEOUSLY

Hydraulic and pneumatic lines can be quickly, easily, and safely connected or disconnected with the Hansen High Pressure Two-Way Shut-Off Coupling—with both ends of line positively sealed when coupling is disconnected.

To connect, you merely pull back sleeve and push plug into socket. Identical torpedo type valves in plug and socket are mounted to permit free flow of gas or liquid when coupling is connected.

To disconnect, just pull back sleeve—coupling immediately disconnects, valves automatically and instantly seal both ends of line.

Plugs and sockets furnished with ½" Female Pipe Thread connections.

### *CAN BE AUTOMATICALLY DISCONNECTED TO PROTECT FLUID LINES*

For applications where fluid lines would otherwise be damaged by sudden strain, the Hansen coupling can be mounted in a stationary bracket to pull back sleeve and disconnect coupling instantly and automatically—leaving fluid lines free, positively sealed, and—undamaged.

*Write for Catalog*

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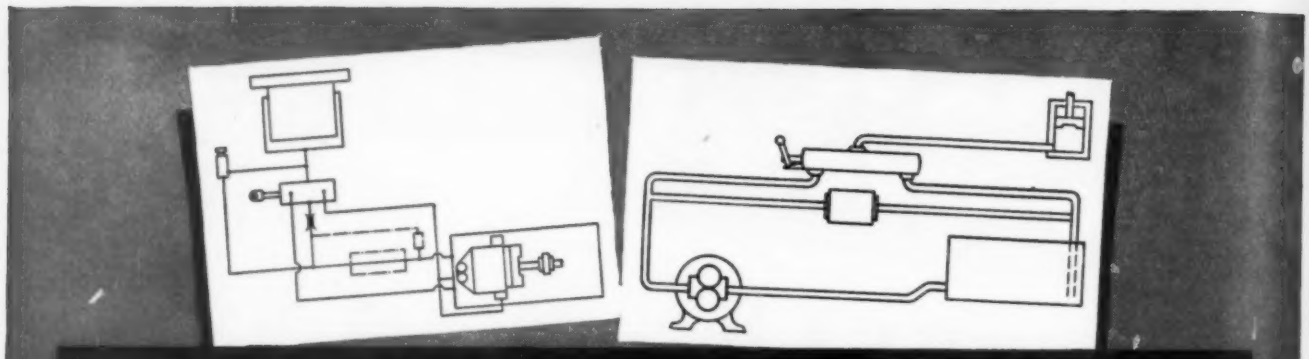


# A Beginner's Course in Basic Hydraulics

CHAPTER VI

# COMPOUND AND PRESSURE REDUCING VALVES

## Compound Relief Valves
## Part 1

This series has been adapted from a special text prepared by the Standards and Curriculum Division, Training Bureau of Naval Personnel, United States Navy. This material is used by permission. Any further reproduction use must be authorized by Bureau of Naval Personnel, Department of the Navy.

### Intermediate Types

A SIMPLE RELIEF VALVE CONSISTS of a check valve set by a spring to open at a certain pressure. A compound relief valve consists of a pilot valve operating in exactly the same manner as a relief valve and a main valve which opens and closes as a result of the action of the pilot valve. The valve will open or close because pressures are different over equal areas, equal pressures act over unequal areas or both. In each case, inequality of opposed forces or a pressure differential causes the valve to open or close.

As we have seen, a hydraulic system, even when operating normally, may develop a temporary dangerous excess pressure, e.g., when unusually strong work resistance is encountered or the moving element stalled. Relief valves are used to control this excess pressure. Because simple relief valves are sometimes unsatisfactory in operation compound relief valves were developed. A simple relief valve, with suitable spring adjustment, can be set to open when the system pressure rises to say 500 psi. However, when it does open, the volume of flow to be handled may be greater than the capacity of the valve, so that pressure in the system may rise several hundred pounds above the set figure before the valve brings the pressure under control. A simple relief valve would be effective under these conditions only if it were very large. In addition, it would work stiffly and chatter back and forth in its seat.

Then, when the system pressure is reduced, the valve will close at a pressure *below* the set figure. As indicated in Figure 74, the seating surface of the valve must be wider than

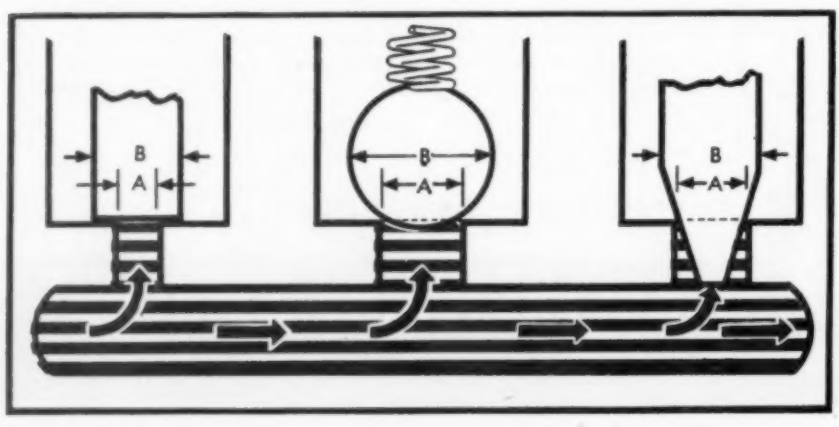



**Fig. 74. Three different relations of seating surface of valves to pressure openings are shown schematically. The seating surface of the valve must be wider than the pressure opening if the valve is to seat satisfactorily. In each case A represents the pressure opening, B the seating surface.**

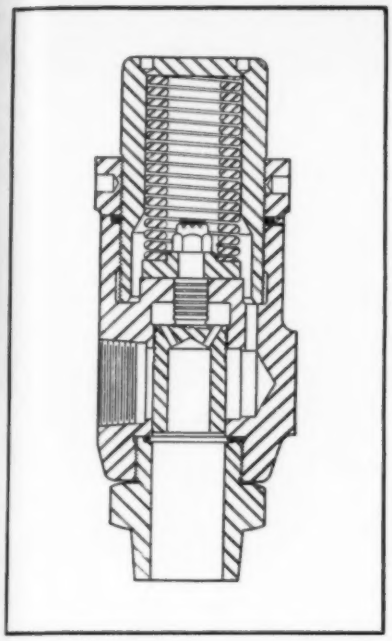


**Fig. 75. Differential relief valve with by-pass orifices through plunger to dampen the pressure and permit quiet operation.**
*Hydraulic Power Division, The Hydraulic Press Mfg. Co.*

the pressure opening if the valve is to seat satisfactorily. The pressure in the system acts on the area of the valve open to it. In each case, Figure 74, the force exerted *directly upward* by this pressure when the valve is closed depends on the horizontal area across the valve at A. However, the moment the valve opens, the upward force exerted by the pressure will depend on the horizontal area of the valve at B, which is necessarily greater than the area at A. This leads to an upward jump in the action of the valve immediately after it opens, and it also sets up a greater force opposed to the closing of the valve than was needed to open it. As a result the valve will close at a lower pressure than the pressure at which it opened.

For example, the valve may be set to open at 500 psi. If the upward area at A exposed to this pressure when the valve is closed is 0.5 sq in, an upward force of 250 psi (500 x 0.5) will be exerted on the valve at the moment of opening. With the valve open, however, the pressure acts on the area at B, which might be one sq in. The upward force would then be 500 psi, or double the force at which the valve actually opened. For the valve to close, pressure in the system would have to fall well below the figure at which the valve opened. The exact pressure at which the valve would close would depend upon certain geometrical relations of the particular shapes involved.

It follows that simple relief valves are liable to open and close rapidly as they ***hunt*** above and below the set pressure, causing pulsations and undesirable vibrations in the system, and producing a noisy chatter. Compound relief valves use the principle of action of simple relief valves for one phase of their action—that of the pilot valve—but provision is made to limit the amount of liquid that the pilot valve must handle, thereby avoiding the weaknesses of simple relief valves.

We will briefly describe four standard relief valves that might be considered as intermediate types between simple and compound relief valves.

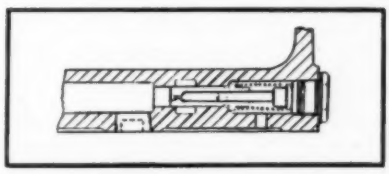


**Fig. 76. The Oilgear low pressure relief valve used in radial piston pumps to limit the pressure of a built-in gear pump.**
*The Oilgear Company*

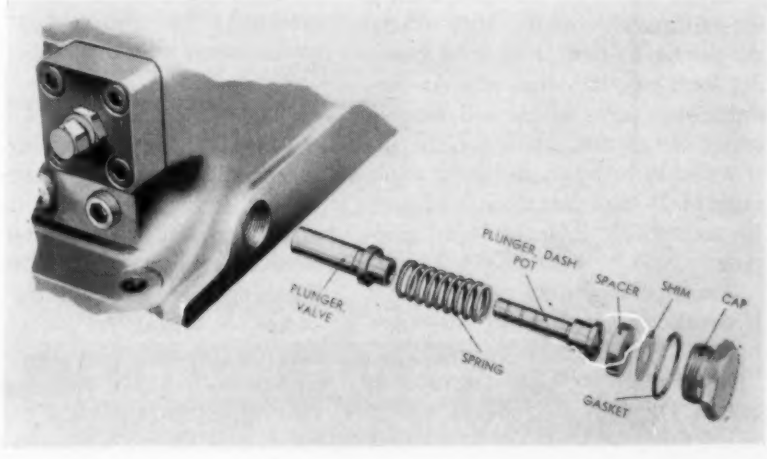
Figure 75 shows a differential relief valve made by the Hydraulic Power Division of The Hydraulic Press Mfg. Co. The large plunger in the path of the entering pressure has by-pass passages which permit free access of a part of the pressure to the chamber above the plunger. This dampens the upward thrust so that only the net thrust or load acts on the spring. An examination of Figure 75 indicates that this net thrust is that of the pressure acting on the small stem extension of the plunger, and that a large area is provided for the escaping fluid. This checking or partial balancing of pressures on the plunger assures quietness of operation.

Figure 76 shows a low pressure type relief valve which is used in Oilgear radial piston pumps to limit the pressure of a built-in gear pump used essentially for controlling and supercharging purposes. It employs a stationary dashpot plunger which is closely fitted to a spring loaded valve plunger. While the stationary plunger partially balances the pressure load on the relieving plunger, an orifice in the end of the relieving plunger cushions or dampens the rising and seating action of the relieving plunger through the dashpot below the stationary plunger to eliminate chatter and whistle. This type of valve is used to relieve limited volumes at pressures at 300 psi.

Figure 77 is an exploded view of this valve.

For limiting the high pressure developed by Oilgear radial piston pumps, most units incorporate one or two reverse flow type relief valves, shown in drawing, Figure 78 and photograph, Figure 79. In this design there is a close fit between plunger and bushing at both the small and large diameters, "A" and "B". The seat is at "C". A small "V"

**Fig. 77. An exploded view of the Oilgear gear pump relief valve.**
*The Oilgear Company*



groove relieves the fit at the small diameter "A". Pressure at the inlet port acts on the small shoulder (B minus A) through the "V" groove. When the presure of the fluid raises the plunger, the oil exhausts past the seat "C". The pressure filled dashpot above the pressure chamber stabilizes the plunger actions to make operation accurate and sensitive over a wide range with relatively low peaks with suddenly applied pressures. Plunger is hollow to allow oil to drain from spring chamber without using external piping. By using a solid plunger (detail, Figure 78), this same valve can be used for two-way operation. Area "A" can be made the same as the shoulder area (B minus A) to provide the same resistance when pressure is applied to the end of the plunger or on the shoulder.

The Gerotor May relief valve, Figure 80, employs a balanced valve piston to relieve the pressure into the exhaust. An independent lifting plunger works against the spring tension to lift the piston. The spring tension is adjustable. The outlet pressure is prevented from acting on the valve plunger by a drain connection from the spring chamber.

***Part II which treats of compound valves will appear in the May issue. Save all installments for future reference.***

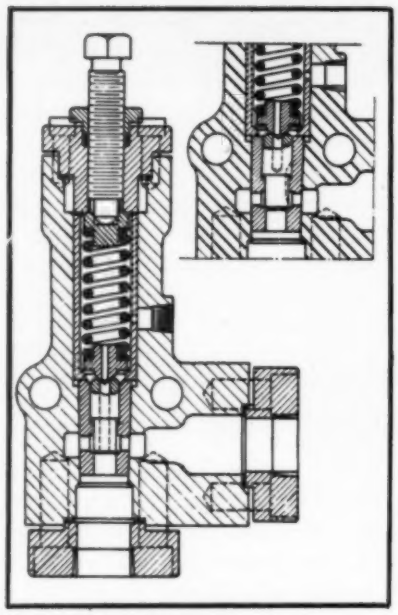


**Fig. 78. The high pressure, reverse flow type Oilgear relief valve. Both hollow and solid plunger designs are shown.**

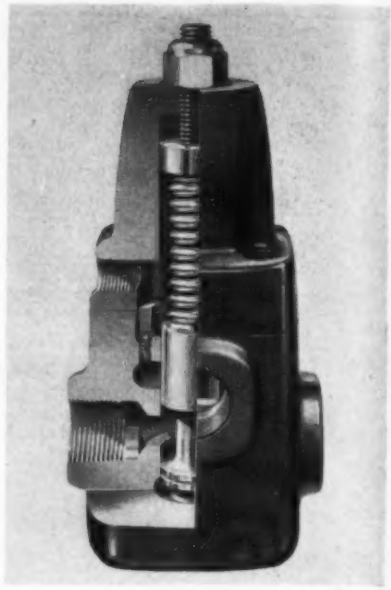
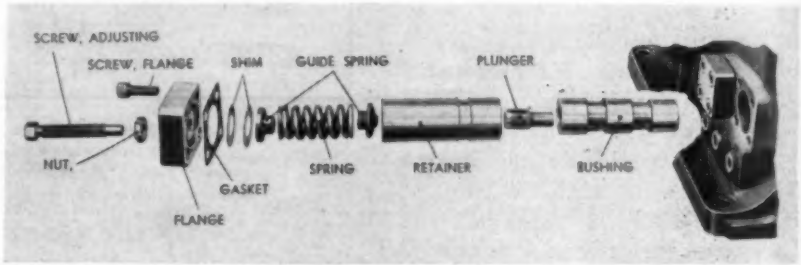


**Fig. 80. The Gerotor May relief valve, a balanced piston type, employs an independent lifting plunger which works against spring tension to lift the valve piston to relieve pressure to exhaust.**
*Rivett Lathe & Grinder Inc.*

**Fig. 79—Exploded view, Oilgear high pressure reverse flow relief valve.**
*The Oilgear Company*




## TREATED HYDRAULIC OILS

*(Continued from page 23)*

provide ample protection for temporary protection. In any event, the relatively small amounts of rust inhibitor used in hydraulic oils may present some advantages, and do not adversely affect the life of the oil.

Where clay type filters are used in continuous circuits, such filters should be by-passed to gain benefits from rust-inhibited oils. As diatomaceous earth filters will remove many of the rust inhibitors, the filters should be by-passed for a minimum of 25 hours for these inhibitors to accomplish their intended purpose.

The rust inhibiting qualities of a hydraulic oil are usually measured by the A.S.T.M. test D-665-42T, "Rust Preventive Characteristics of Steam Turbine Oil". The procedure is briefly as follows:

A mixture of 300 cc of oil is stirred with 30 cc of distilled water at a temperature of 140 F, with a cylindrical steel specimen immersed therein. After 24 hours contact with the oil-water mixture, the specimen is examined for signs of rust. Temperature and time limit may be changed to increase or decrease the severity of the test. From the standpoint of a concern marketing rust preventives for general corrosion preventive use, this test is considered a rather mild one.

### Corrosion Inhibitors

There is a distinction between a rust inhibitor and a "corrosion inhibitor" in the true sense of the word, although often the two terms are used interchangeably. Chemically-speaking, rust is one specific form of corrosion. However, in some instances corrosion inhibitors may be added to hydraulic oils in order to neutralize the tendency of certain base stocks to acidify more rapidly under "hot" operating temperatures or, to inhibit the attack on metals in the system.

### Gum Solvency

Appreciating that all oils, either inhibited or not, will eventually reach a point where oxidation products will deposit out on the working parts of a hydraulic system, solvent properties are incorporated in some hydraulic oil additives to further extend the useful service life of the oil.

The action of this type of additive is to extend the saturation point of the oil beyond that of a straight mineral oil, or one that is merely oxidation and rust inhibited. This, then, is a further protection.

By laboratory tests, certain limits have been established for the ability of an oil to hold gums in solution. Beyond this saturation point, all further formation of gums will be precipitated and will deposit them-

*(Continued on page 52)*

## HYDRAULIC STEERING

*(Continued from page 36)*

tests on airplanes with such an arrangement show promising results.

Standardization of controls for nose wheel steering on military airplanes has just recently been achieved by the Air Forces. These new requirements specify the use of rudder pedal control on all airplanes with stick flight control systems or with bicycle type landing gears such as the Boeing B-47 or Martin B-51. The control for airplanes with wheel flight control systems is to be a small wheel mounted concentrically with the regular flight control wheel. Standardization of steering units has not been achieved as yet. The Air Materiel Command is investigating this at the present time and plans are being made for conducting tests to evaluate steering system requirements for different aircraft. After these tests are completed and the results analyzed, it is quite possible that a standard unit or series of units can be developed for the smallest fighter type ariplane to the largest long range bomber.

## PNEUMATIC SYSTEMS

*(Continued from page 38)*

tronic; however, the small deflection frequently is amplified pneumatically by the double orifice effect.

By allowing gas to expand through two orifices in series, with a pressure sensing device between them, it is possible to get considerable amplification by slightly varying the area of one of these orifices. It is easily possible by this method to get amplification ratio as high as 100,000:1. This effect is used in almost every pneumatic control device requiring high sensitivity.

Many of the pneumatic transmitters for temperature or pressure as used industrially have a small "flag" operated from the sensing element that is moved into the discharge from the sensing orifice to lower its flow rate and thereby obtain a major change in the intermediate pressure. First derivative, proportional and reset type controls using pneumatics directly can easily be added to this pneumatic amplifier to obtain the desired end result.


**PALMETTO®**

**Now you can step out in design with a positive seal—for piston or rod assembly—that won't extrude between mating parts.**

Design of a *single* packing capable of standing up as a positive seal for long periods of rigorous service at severe pressures presented a tough problem to packing design engineers — but Palmetto's G-T Ring Packing has come up with an even more impressive answer than was hoped for.

This packing has already been widely adopted for double-acting hydraulic and pneumatic services—not only for non-extrusion performance but for its ability to seal without leakage to 15,000 psi; from —70 F to 250 F . . . and has proved adaptable as a static seal or as a seal where there is reciprocating or oscillating motion.

Design also allows wider clearances between piston and bore, thus permits wider tolerances and reduces manufacturing costs.

Palmetto's complete answer to this packing need is typical. Investigate the "G-T" . . . the "Pyramid" . . . other packings in the complete Palmetto line. When you have a tough one, think of the Palmetto Packing Specialist.—He'll have the answer and it will always be Palmetto-Perfect.

**THE G-T RING® PRINCIPLE**

**The G-T Ring consists of a resilient sealing ring of synthetic rubber in a T-section supported on each side by two non-extrusion ring retainers.**

Diagram A shows a G-T Ring installed prior to application of pressure. Note the initial squeeze of the synthetic resilient element which provides the seal at no pressure, and the clearance which is allowed at W and X to prevent friction at low pressure.

Diagram B shows the G-T Ring under full pressure. The deformation of the resilient element at Z causes radial swelling of the flange on the low pressure side of the seal, forcing the non-extrusion rings tightly against the cylinder wall at X, preventing the resilient element from extruding into the clearance space at Y. It is this outstanding feature that makes PALMETTO G-T Ring Packing the ultimate in seals.

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"WHEN PACKING PERFORMANCE COUNTS"

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NORTH WALES, PENNSYLVANIA

# Useful Literature

**The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.**

**28. Self-lubricated Packings . . .** Manufacturers of Palmetto (R) self-lubricating packings, the Greene, Tweed & Co. has just issued a new 4-page Bulletin LP-10 which discusses these packings in detail. Illustrations of the types available are shown. Principles of self-lubricating packing design are discussed along with structures, performance and analysis of each individual type of packing. Emphasis is put on applications showing the proper Palmetto packing for particular service.

**29. Pumps . . .** The IMO-DeLaval Products Division, De Laval Steam Turbine Co., has just issued a 4-page IMO Catalog LP which covers condensed data on 6 series of IMO pumps. All pumps are of the three rotor, continuous positive displacement type and are shown in cutaway perspective drawings. Series A21N (10 gpm, and 100 psi) is designed for low pressure hydraulic service. Series A31H (150 gpm and 1500 psi) is offered for high pressure applications. This series has cast steel castings and hardened alloy steel rotors affording smooth, quiet operation. Series A32 (1000 gpm and 500 psi) pumps are recommended for handling lubricating and hydraulic oils in volume. All pumps can be directly connected, easily installed and afford pulsation-free, full axial flow.

**30. Continuous Oil Purifiers . . .** Honan-Crane Corp. has issued a catalog sheet on their line of Continuous Oil Purifiers. Hydraulic oil is purified by passing it through replaceable Cranite. A wide variety of sizes are available, units for 50 gal systems (7.5 in dia x 15 in high) to units for 10,000 gal systems (39 in dia x 60 in high). Specifications give pipe sizes from ⅛ in to 1 in for pump capacities of 90 to 300 gph requiring ¼ to ¾ hp motors. Purifiers for 400 gal and over systems have built-in motors and pumps.

CIRCLE NUMBERS ON THE CARD AND MAIL!

**31. Selectors, Stepping Relays . . .** G. H. Leland, Inc., has just released Bulletin 150-CSR-CP listing a few of the many applications of Ledex circuit selectors and stepping relays. Applications illustrated are remote circuit control for aircraft radio, control boards and drives up to six-way selection. Also shown is the Ledex Solenoid, manufactured with starting torques for 45 degrees stroke range from ¼ to 50 lb in.

**32. Percentage Timer . . .** Bulletin No. 2500F issued by The R. W. Cramer Co., Inc., describes the Type PE percentage timer designed to automatically control the percentage of open and

## THE CONTOUR MACHINE

*(Continued from page 29)*

bined with the pressure control. The variable feed rate, a new feature with hydraulic control, automatically compensates for tool wear, giving optimum tool life and cutting rate.

A 2 in diameter cylinder feeds and returns the table for a total stroke of 16 in.

Table tilt is accomplished by the 1¾ in dia table tilt cylinder operated by dial control of the four-way tilt valve. The table can be tilted ten degrees to the left or 45 degrees to the right (Figure 3) and held in the set position by a manual lock.

### Speed Variation

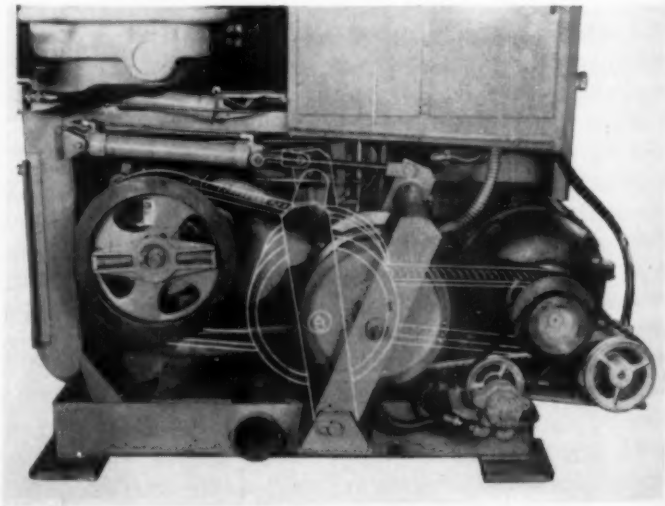
Speed variation is hydraulically controlled. Figure 1 shows an operator setting a change on the speed change dial. The four-way valve speed change valve controls the 1¾ in dia variable speed cylinder. This cylinder controls the transmission and variable speed unit, Figure 5. The drive assembly has a 7½ hp motor, belt driving the three-speed transmission (and the hydraulic pump), the transmission being driven through a variable pitch diameter sheave assembly which has a total speed ratio of 250:1, giving infinitely variable, stepless speeds between 40 and 10,000 fpm.

A special torque limiting feature, built into the transmission input sheave, limits the horsepower transmitted to the rotating members, protecting belts and mechanical parts in case of an overload.

The hydraulic system, in spite of the number of different and independent functions it performs, is not complicated. The system, made up of self-contained units, is easily accessible for service or maintenance. Pipe and pipe connections have been held to a minimum by means of manifold construction and compression fittings. Adequate interlocks provide for safe operation.

The application of hydraulic power to the Contour-matic marks a large stride forward in the versatility of the machine and its adaptability to production manufacturing. Greater capacity, safer, easier operation, less downtime and maintenance all add up to the production goal of cutting costs.

**Fig. 5. The variable speed cylinder (top, left) controls the transmission and variable speed unit. A three-speed transmission is belt driven through a variable pitch diameter assembly, providing infinite, stepless speeds from 40 to 10,000 fpm. The pump is also belt driven off the motor shaft.**



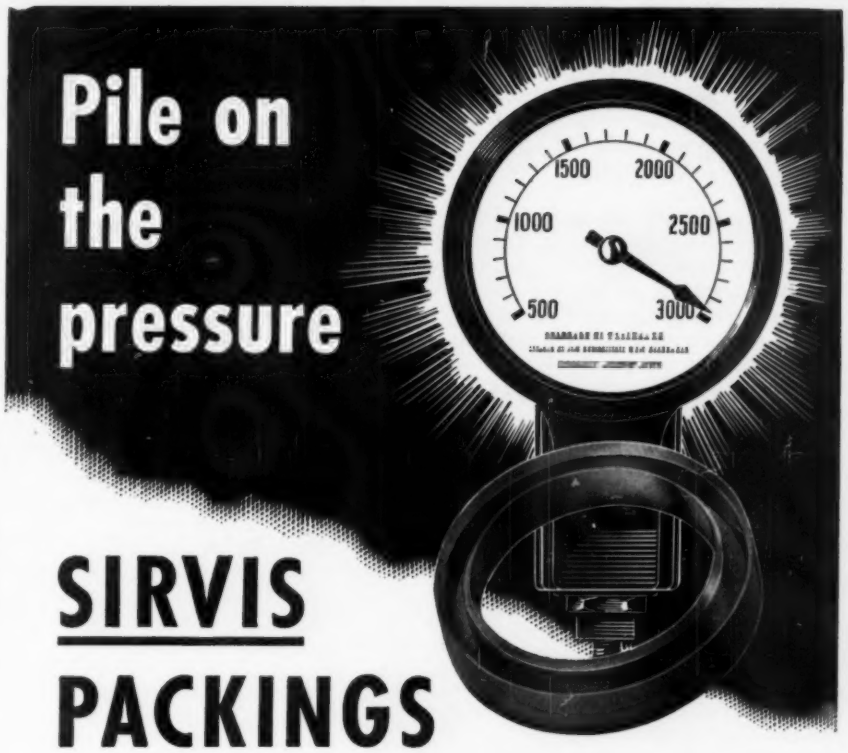
closed time on AC electrical circuits. Some of the uses include pumps, filters and automatic lubricating systems. The timer is simple and compact, and is available in 12 speeds. Dials are calibrated in steps of 1 per cent from 4 per cent through 96 per cent and read either on or off time. The self-starting synchronous motor driving through a gear train is inclosed in a dust proof housing. Time ranges and price list is given with ordering information.

**33. New Bronze Valve . . .** Manning, Maxwell & Moore, Incorporated, announces the 150 pound Hancock "500 Brinell" Bronze Valve series, a completely new line of general purpose Hancock valves. Sizes are from ¼ to 2 in in both the angle and globe types are charted. These valves have extra heavy diaphragm construction renewable plug seats, stems of aluminum silicon bronze, reinforced basket-type handwheel. Packings are of asbestos lubricated with graphite.

**34. Magnetic Plugs . . .** The U. S. Plug & Fitting Company in a release announces a new line of Magnetic Plugs, sizes ¼ in to 1½ in, square head, countersunk and special. The new plugs effectively remove and hold ferrous metal particles from moving fluids. By varying the length of the support stem the Sintered magnet can support up to 11 ozs. A non-ferrous metal attaches the magnet to the stem. Plugs have Dryseal Threads, U. S. ⅛ to 4 in and are interchangeable.

**35. Boosters and Accumulators . . .** Miller Motor Company has just published a 12 page illustrated bulletin, B-200, describing fluid pressure boosters and accumulators, their theory, application and method of selection. Frank Flick, Miller's chief engineer, describes the types and benefits of boosters and gives formulae for calculation of booster circuits. Drawings show the operation and limitations of single and dual boosters. A selection chart is shown along with a simplification of the formulae for easy application. The Miller B2 and B4 model boosters with Model BA7 and BA8 booster circuits are described. The section on accumulator circuits gives mounting and operating pressure data with drawings showing the types used. Ordering information and an illustration of a typical booster application are included.

**36. Shaft Seals . . .** Bulletin No. B-571 of the Peerless Pump Div. of Food Machinery and Chemical Corp. presents four types of hydraulically balanced, abrasive-resistant mechanical seals. The seals have cemented tungsten carbide or carbon sealing faces for both stationary and rotating rings, affording positive sealing of abrasive and non-lubricating liquids. Two standard or limited abrasive-resistant, one abrasive-resistant, and special types of seals are available. All seals are of the cartridge type and available as double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seals. Water, gasoline, hydraulic fluids as well as corrosive fluids can be successfully sealed. Diameters from ½ in to 3 in can be furnished, larger sizes on request. Working pressures up to 400 psi on the seal with temperatures up to 250 F are standard.

**37. Hydraulic Weighing . . .** Bulletin 303 has been issued by the Testing Equipment Department, The Baldwin Locomotive Works, to describe and illustrate the various components of the hydraulic weighing systems for varied applications in industrial plants and testing laboratories. Information on the selection of components is given. The components shown include Emery hydraulic cells ranging in capacity from 1000 to 100,000 lb capacity for compression and tension loads, crane scales and portable cells with integral Emery bourdon type indicators. Information is also included on indicators, hydraulic lifting jacks and hand pumps for use with compression type load cells.

**38. Dynamometers . . .** Bulletin 760 available from Taylor Dynamometer & Machine Co. presents the very complete line of Taylor HI-EFF Dynamometers. Illustrated are the Power Absorption type machines. Draw bar type and others are available. The HI-EFF assures accurate data with economical performance, using 3 to 4 gal of water per bhp hour; 72 different capacity models are available from standard patterns. Typical of flexibility of the HI-EFF line is Model D-24 which calibrates from 10 hp at 1000 rpm to 450 hp at 6000 rpm. Smooth, true torque scale readings result from adjustable hydraulic controls. Lo-speed, Hi-torque and reversible machines are made in addition to balancers and precision drilling machines.

**39. "O"-Ring Hydraulic Packings . . .** Standard sizes, specifications and installation data for "O"-rings are described in a 10-page catalog, 9-A, of the Minnesota Rubber and Gasket Co. Mechanical, chemical and electrical properties of leading synthetic rubbers are classified for comparison. Standard sizes are given from ¼ to 1¾ in OD. A table of recommended diametrical interference or squeeze data is included.

**40. Angle Drives . . .** A 4-page Bulletin by Airborne Accessories Corporation has been issued to announce their improved model ANGLgear, right angle gear unit designed for universal mounting in aircraft and industrial applications. Two basic models are made, a 2-way and a 3-way drive with 1 to 1 ratio standard and 2 to 1 optional. Standard static torque is 250 in lbs but units rated at 500 in lb are available.

**41. Selection of Air Compressors . . .** Pneumatic Automotive Equipment Assn. has published a 12-page handbook of valuable air compressor data entitled "How to Select an Air Compressor of the Right Size and Type". The booklet has four sections, two devoted to selection and one each to installation recommendations and maintenance instructions. The steps to selection are given with charts showing the demands of various pneumatic equipment, examples of how to sum up the demand and transfer the total to a selector chart which gives the size compressor required. Industrial applications are treated with charts and examples for getting the right compressor for the job. Installation recommendations give sound procedure to follow after the compressor is purchased. Wire and pipe sizes are tabulated to take guess work out of installation. A check sheet on maintenance is included.

CIRCLE NUMBERS ON THE CARD AND MAIL!

**42. Carbon Seals and Rings . . .** The Morganite Brush Co., Inc., have a new brochure discussing carbon rings and seals. The Morganite rings and seals are resistant to acids and alkalis, high temperatures (to 850 F) and have low thermal expansion characteristics. They are friction resistant and reduce wear and scoring. Seals and rings are available in any size or shape up to 20 in in dia and any thicknesses. Tolerances are held as close as .001 in on molded parts. Drawings of typical installations are shown.


# A Small Valve for BIG JOBS
## ...NOPAK 4-Way Model SL RING-TYPE Solenoid VALVE

**Does the work of bulkier, heavier and costlier solenoid valves of same capacity. Designed for air operation only, at pressures from 40 to 250 P.S.I. Functions effectively mounted in any position. Employs solenoid-actuated pilot rather than direct solenoid pull on sealing mechanism.**

● **NOPAK Model SL, 4-Way Ring-Type Solenoid Valve. Weight 5¾ lbs., 5⅞" long, 3" wide, 5½" high. ½" pipe size only. Cylinder Ports may be reduced to ⅜" or ¼".**

### Has the Features you Want!

1. Light 3-piece valve body of drawn aluminum.
2. Chrome-plated Operating Shaft floats in Neoprene O-Rings — requires minimum lubrication.
3. Standard Solenoid Unit — easily replaced, readily available.
4. Current Economy — 0.96 amperes at 220 volts.
5. This valve gives you long-run, high speed operation . . . up to 500 cycles per minute . . . or continuous energization in one position.
6. Sub-Plate mounting furnished at extra cost, if desired.

**NOPAK**
**VALVES AND CYLINDERS**
**DESIGNED for AIR and HYDRAULIC SERVICE**

**Write for Bulletin SL**

**GALLAND-HENNING MFG. CO.**
**2743 SOUTH 31ST STREET**
**MILWAUKEE 15, WISCONSIN**

***Representatives in Principal Cities***

A 5740-½H

**43. Diaphragm Control Valves . . .** Descriptions and drawings of diaphragm control valves are offered in Bulletin 700-1 published by the Belfield Valve Division of the Minneapolis-Honeywell Regulator Co. Specifications, construction and material are given for the air operated diaphragm motor controlled valve, valves with radiation fins and with positioner; direct and reverse acting diaphragm valves; and others. Also included in this illustrated, 32-page catalog are dimension tables and ratings, shipping weights and cubical measurements. A section is devoted to pilot piston control valves with flow charts and specifications.

**44. Air Shut-Off Valves . . .** The Homestead Valve Mfg. Co. has issued a small leaflet on their ½ and ¾ in line of air shut-off valves. Featuring renewable flexible discs, cam operated lever, and economical in first cost and maintenance, these valves operate at working pressures to 150 psi. They can be used as quick-acting valves on drills, clamps and any other hand tools. A table is included giving the cost of air leaks for standard sizes of opening at 100 psi.

**45. Stainless Pipe and Tubing . . .** Condensed data on the physical and heat properties of a new stainless steel tubing, Croloy 18-8 Cb, has been issued by the Babcock & Wilcox Tube Company in their Technical Data Card 132. By adding columbium to stainless steel, corrosion is reduced and the "stainlessness" of the metal preserved. Creep strength, oxidation resistance, machinability and heat treatment are fully explained. A graph of tensile properties with increasing temperature has been included. The suitability of this alloy in applications where welding is not followed by annealing has been suggested.

**46. Reversing Contactor . . .** Struthers-Dunn, Inc., has released Data Bulletin 7100 on their new reversing contactor type 175 KXX for use with installations requiring frequent motor reversal. The contactor consists of two 3-pole solenoid operated contactors mechanically interlocked to prevent simultaneous closure. This contactor will find uses with hoists, motorized valves, machine tool auxiliaries and many other industrial machines. Electrical and mechanical specifications and a price list are included.

**47. Hydraulic Cylinder Applications . . .** A technical information bulletin CS 248, describing the use of hydraulic actuating cylinders for removal of mold cores from fresh concrete pipe during production is announced by Ledeen Mfg Co. The difficult core removal and time saving solution using Ledeen heavy duty cylinders is described, along with cylinder and pressure information. This application suggests the use of hydraulic or pneumatic cylinders for other straight line motion problems. The heavy duty cylinder has a 3 in dia bore with a 48 in stroke operating on 1000 psi.


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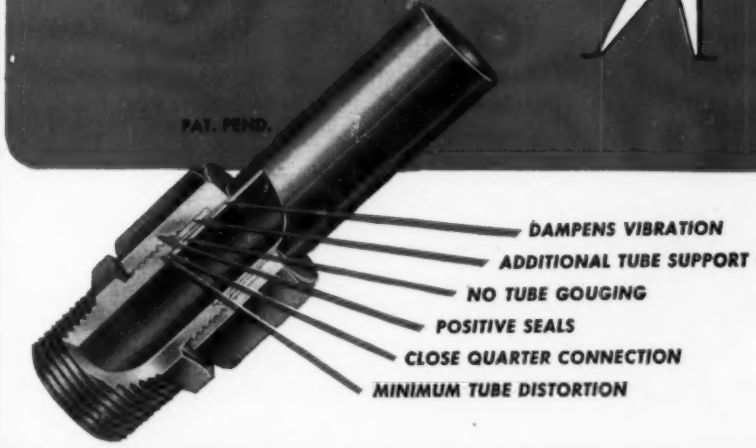
**a NEW all-purpose Flareless Fitting**

*as simple as* A B C




**IMPROVED DESIGN** of the AFCO flareless fitting eliminates tube gouging and limits tube distortion — permits quick economical installation without special tools, requires no tube flaring, and is ideally adaptable to close quarter connections.

**LEAK-PROOF — PRESSURE-PROOF** — the gripping action of the fitting sleeve forms a positive leak-proof seal and makes the fitting especially suitable for thin wall tubing of brass, copper, steel, stainless steel, or aluminum alloy.

**PRECISION MADE** — AFCO fittings are available in all popular shapes for tube sizes up to and including 1 inch. Special sizes and shapes for tubing up to two inches O.D. can be furnished. All "AFCO" fitting shapes (elbows, tees, etc.) are machined from forgings — all other parts are machined from bar stock.

**MEETS ALL SPECIFICATIONS** — The AFCO flareless tube fitting meets all requirements of the J. I. C. Hydraulic Standards for industrial equipment and Specification AN-F-47. Because of close tube fit, the AFCO Flareless Fitting is particularly desirable in connection with food processing where sanitation and cleanliness are so vital.

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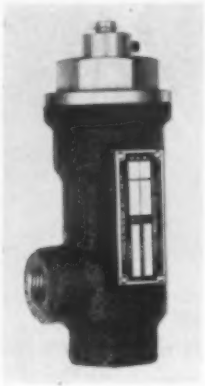
**LARGEST PRODUCER IN THE COUNTRY**
**ENGAGED EXCLUSIVELY IN THE MANUFACTURE OF FITTINGS**

# New PRODUCTS

**For additional information on any of these products, mark the end key numbers on the card bound in this issue and mail the card.**

### New Hydraulic Relief Valve

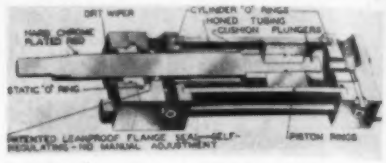
A new cartridge type hydraulic relief valve, with pressure settings from 100 to 5000 psi, has been announced by the Hydraulics Division of Pantex Manufacturing Corporation. This valve meets



AN Specification AN-V-1b and is entirely silent with constant repeat accuracy assured. The new valve opens and closes within a seven per cent differential with smaller differentials available. The entire operating mechanism is contained in a cartridge which can be replaced without breaking the line. Pressure adjustments are made by means of an accessible adjustment screw. *1.*

### Hydraulic Cylinders

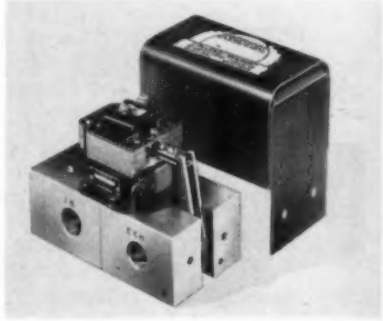
High pressure hydraulic cylinders that meet J.I.C. Hydraulic Standards are now offered by Miller Motor Co. These cylinders with solid steel heads, caps and mountings are available as a standard line from 1½ to 12 in bores for operating pressures from 2000 to 3500 psi. "O" rings provide required leakproof pressure sealing; a patented leather rod seal assembly permits friction free leakproof operation of the reciprocating rod. Cylinder bores are finished to 15 micro inches. Automatic step-cut piston ring assemblies are available and interchangeable with the standard leather cup seal assembly.




Cushioning at one or both ends is available. *2.*

### Ring-type Valve

A new lightweight ring-type solenoid air valve, Model SL is announced by Galland-Henning Mfg. Co. Embodying a solenoid-actuated pilot rather than the conventional direct pull on the sealing mechanism, line pressure is always



on the same cylinder port and the other port open to exhaust before the solenoid is energized and cycle reversed. The 3-piece valve body is easily dismantled, the solenoid easily replaced; tests indicate the valve will operate completely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  for ⅛th to 2 inch O.D. tubing
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  3 PIECE LOCK-JOINT-SLEEVE TYPE
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*Hydraulic Accessories*

**L&L MANUFACTURING CO.**

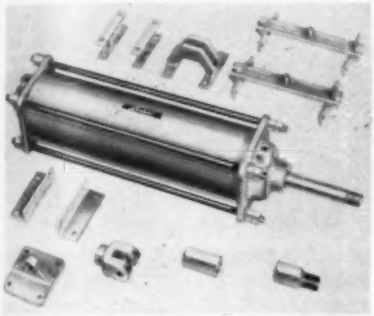
8088 EAST NINE MILE RD. VAN DYKE, MICH.

submerged in oil. Model SL, available in ½ in pipe size, is designed for operation at air pressures from 40 to 250 psi. *3.*

**CIRCLE NUMBERS ON THE CARD AND MAIL!**

### Air and Hydraulic Cylinders

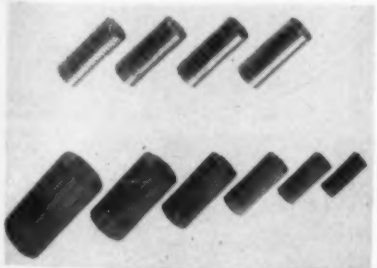
A Medium Duty Series of air and hydraulic cylinders is announced by Ledeen Manufacturing Company. These cylinders are now being manufactured for industrial use wherever straight line motion is required; for remote control operation, material handling, clamping or holding, and a multitude of other uses. Cylinders utilize tie-rod construction to give positive protection against leakage at joint of tube and head. Chevron packing is used to seal piston rod.



Synthetic cups and automatic cushion are standard construction. These cylinders are manufactured to a completely standardized design and with the various head and rod attachments provide for almost universal mounting requirements. This series with the Heavy and Super Duty series offer an exceptionally wide selection of cylinders which may be of special interest to original equipment manufacturers. *4.*

### Fine Screen Strainers

Yarnell-Waring Company, manufacturers of the Yarway strainers, feature a line of filter screens and metal filter cloth for pipe strainers in steam traps, reducing valves and other types of equipment. The screens prevent rust, scale and dirt from clogging the traps behind the strainer. Screens, in the top row, are made for the Yarway screwed-end strainers, sizes 12 in to 2 in and are



made of Dutch weave, Monel wire filter cloth that has small triangular openings for fine straining with large free area. The triangular openings afford greater mechanical strength than square openings. Screens, shown in the lower row, are used in Yarway flanged strainers and are made of perforated brass, Monel or other metals. *5.*


# GREER HYDRAULIC ACCUMULATORS

- REDUCE OPERATING COST
- INCREASE PRODUCTION
- SAVE TIME AND MANPOWER

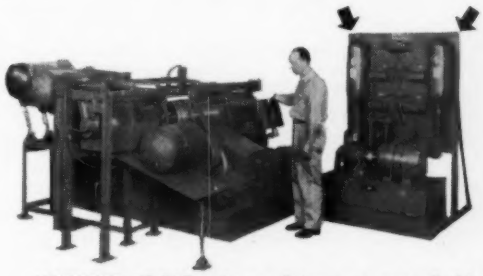
United States Patents Under Oleer Licenses

THE illustrations shown here are vivid examples of what Greer Accumulators have done for hydraulically actuated machines.

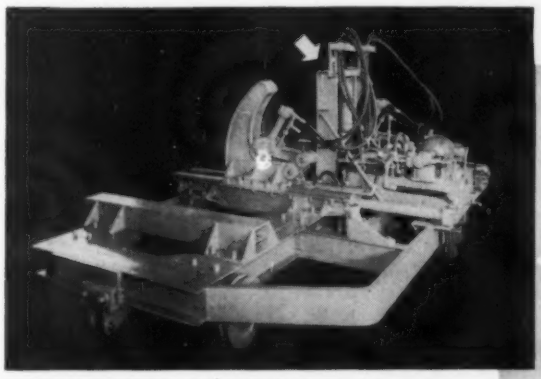
These are but a few of thousands of actual installations where accumulators are effecting greater economy; increased production and new high standards of safety.

No matter what industry you may be in, no matter what equipment you are using, if you use hydraulics, it will pay you to investigate what this accumulator can do for you.

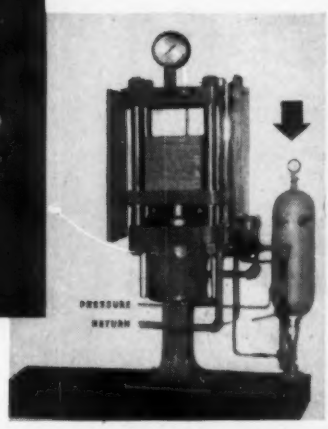
A request for details on your company letterhead will bring an immediate reply. Write today.



MACHINE TOOLS — Accumulators cut cost of this machine $600.00—Reduces its weight 400 lbs.



HUGE PULPWOOD CARRIAGE: Accumulator reduces Horsepower Requirement — Saves Time — Eliminates Need for Operator on Carriage.




PRESS INSTALLATIONS: Accumulator compensates for leakage during holding operation—Eliminates pressure drop in multiple press installations.

**CAPACITY**
From 2 cubic inches to 10 gals.

**PRESSURE**
Up to 3000 psi

**TYPICAL USES**

As a storage chamber and Shock absorber.
As an emergency source of fluid power.
For operating secondary systems.
As a dispenser of oils or greases.
As a thermal expansion compensator.
To reduce size of power unit in intermittent duty cycles.

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GREER HYDRAULICS INC.

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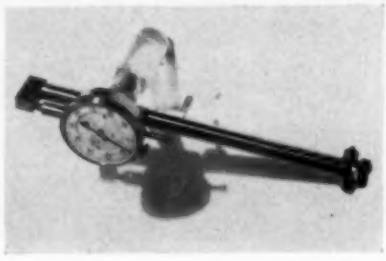
### Cylinder and Shaft Seals

A new 3-piece cylinder and shaft seal with wide application in industry has been developed by Auto-Diesel Piston Ring Company. The 3-piece design eliminates blow-by leakage of air, gas or liquid past the piston ring insert or

split expansion ring necessary for installation. The seal consists of one inner ring and two extremely close fitting staggered outer rings. This seal is used in hydraulic hoists and pumps. *6.*

### Dial Bore Gauge

An entirely new dial bore gauge utilizing a design similar to that of their inside micrometers is announced by the Rimat Machine Tool Co. The new tool is made for quick readings of diameters of internal grooves for "O" rings, snap rings and oil rings as well as diameters of straight bores. Deep bores are measured as readily as shallow ones at a minimum of operator skill. The new



gauge is in two series; S for direct readings in thousandths and T giving plus or minus readings in tens of thousandths for any set dimension. Both series cover a range of diameters from ½ to 6 in. *7.*

### Hermetically Sealed Micro Switch

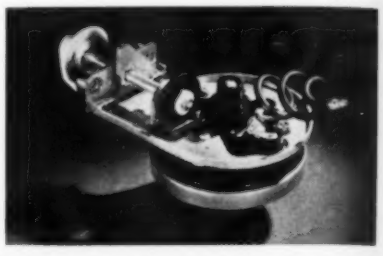
An hermetically sealed precision switch for operation through a wide range of temperature and pressure has been developed by Micro Switch. In industry, the seal will guard against corrosive atmosphere and surrounding liquids so that the explosion-proof switch may be operated under oil or other nonconductors. The sealed case is metal and filled with inert gas. The switch base has rugged terminals which prevent strain on the glass seal around the conductor. This switch is interchangeable in all Micro Switch housings which previously used Type Z pin plunger switches. *8.*

### Portable Lubricator

Aro Equipment Corp. has designed the new Aro "Thrifty-Fifty" portable lubricator for fast and thorough grease jobs. It has a full size automatically oiled pump with 36:1 piston ratio delivering up to 6000 psi grease pressure. The swivel mounted dual-action control nozzle permits free or controlled flow in any direction. The cabinet, mounted on a caster equipped body, holds drums to 50 lb capacity or 60 lb bulk lubricant. *9.*

### Precision Pressure Switch

The Soreng Manufacturing Corporation announces a flexible precision pressure switch for accurate level control of moderate heads of water or other liquids without the use of floats. The switch range may be set to operate on



heads from 6 in to 14 in and reset on heads as low as 1½ in. A specially engineered diaphragm and pressure plate transmit the actuating force to a single-pole, double-throw, snap-action switch rated at 6 amps, 125 volts AC, induced load. *10.*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79 MODELS

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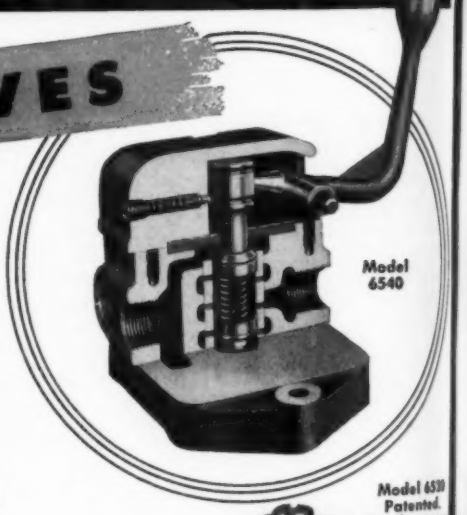
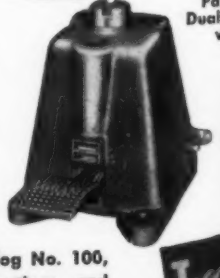
- COMPACT DESIGN
- EASILY INSTALLED
- MINIMUM DOWN TIME

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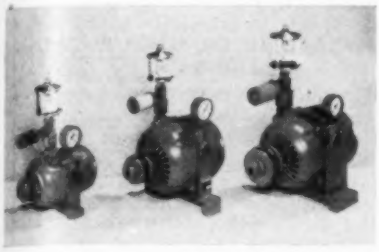
### Improved Pump Housing

Gast Manufacturing Corp. has an improved housing for their heavy duty rotary vacuum pumps and compressors. The new more attractive design offers several advantages in addition to being simpler and more streamlined in shape.



It has less overall height, however mounting dimensions have not been changed so that new models are interchangeable with older Gast models. Integral cooling fins dissipate heat more rapidly. Where pumps or compressors are mounted externally this new housing will improve appearance, save space and will afford efficient maintenance. *11.*

### Foot Treadle Switch

Simonds Machine Co., Inc., announces a new Linemaster twin compact foot treadle switch for industrial use. The twin compact, a double throw switch for forward and reverse action consists of a pair of tiny 6½ oz compacts mounted on a cast aluminum base, with a bridge between to prevent accidental operation. The actuating mechanism mounted on a non-skid base is absolutely foolproof. *12.*

### New Hydraulic Relief Valve

A new larger size of two pressure Hydraulic Operating valve, 2½-3 in Series 805, has been added to the Seely Instrument Co., Inc., family of valves. This series is air pilot operated and has applications in the hydraulic machine field where long stroke low pressures are followed by high working pressures. The Series 805 is composed of three units joined by nipples into one working unit. The main element is the newly designed 2½-3 in Series 808, three-way

valve. This valve can be tapped either to 2½ or 3 in NPT. Auxiliary elements are a check valve, provided with interchangeable seating and reversible disc and an automatic high pressure inlet valve. The valve is poppet type throughout with all discs and seats of hardened stainless steel. *13.*

### Compressor Speed Regulator

The new model UL-83 "Floating-Speed" regulator for portable compressors has been announced by the Ingersoll-Rand Company. The new regulator is much simpler in operation and easier to adjust than the original multi-speed regulator, now in use for ten years. Speed steps and cycling are eliminated; average air pressures are 15 to 20 psi higher and savings in fuel are up to 40 percent. The new UL-83 automatically varies the speed by adjusting the engine governor spring. Whenever less than full capacity of the compressor is used, the new regulator slows down the compressor to the working speed that compresses just enough air to hold the pressure. When the air demand changes, the speed "floats" up or down to the exact speed required; the compressor capacity is varied throughout the entire speed range without speed steps or cycling. *14.*

### Manual Starters

The Trumbull Electric Manufacturing Co. announces a line of manual starters to provide overload protection for small motors up to one hp. The TT (thermostatic tumbler) manual starters are available in single or double pole type for surface mounting (illustrated) or without enclosure. A metal handle guard welded to the switch enclosure provides protection to the handle and permits locking in ON and OFF positions. The switch will withstand a heavy starting load or brief overload but will trip before damage can occur. A wheel-type, movable contact of silver cleans as it rolls against stationary silver inlay

*(Continued on page 53)*

**Lindberg Air & Hydraulic Cylinders are available in a complete range of mountings—with any length of stroke.**

- ★ **Hydraulic Cylinders for pressures to 1500 PSI**
- ★ **Ten standard bore sizes from 2" to 8" inclusive**
- ★ **Standard air cylinders for pressures to 150 PSI**
- ★ **Mill-type heavy duty air cylinders for pressure to 250 PSI**
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- ★ **Cushioned or non-cushioned**
- ★ **Non-rotating—double acting**
- ★ **Special cylinders built to order**

***Write for Bulletin 700, "Hydraulic Cylinders," or Bulletin AC-2, "Air Cylinders"***

**LINDBERG AIR & HYDRAULIC CYLINDERS**

**Lindberg Engineering Company, 2441 West Hubbard Street, Chicago, 12, Ill.**

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## IN THESE HYDRAULIC PUMPS and FLUID MOTORS

There's plenty of power in Eastern fluid motors and hydraulic pumps. They're tough and compact—ideal where space is at a premium. They're dependable, too. Long life under rugged operating conditions is built-in. An Eastern hydraulic pump or fluid motor in your design is good engineering.

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.1 to 5 GPM—Drive speeds up to 3450 RPM. Working pressures up to 1000 PSI. Average volumetric efficiency: 90%. Average model weight: 1.65 lbs.

Lightweight construction is obtained through use of aluminum housings and nitralloy gears and shafts. Each unit is factory pre-tested for precision and operating efficiency.

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**These columns are limited to Help Wanted or Position Wanted ads, and offerings of used equipment by the users of such equipment.**

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Designer with experience in application of hydraulics to machine tools. Position open with well-established New England concern. In reply, please give full details of experience and background. Address Box 4150, APPLIED HYDRAULICS.

## TREATED HYDRAULIC OILS

*(Continued from page 43)*

selves on valves, pumps or other critical working parts of the mechanism. Troubles from such gum formations are familiar to the operator and maintenance men in plants using hydraulic machine tools. Figure 4 shows the size and consistency of a chunk of "gunk"—sludge and pipe compound (oxidized oil and asbestos) taken from the hydraulic system of an injection molding machine.

To act further as an "insurance policy" against such gum depositions, these gum solvent additives are included to hold gums in harmless solution by as much as two to three times as long as can be expected of a hydraulic oil not similarly treated. Thus, an oil containing both an oxidation inhibitor and gum solvency inhibitor may be termed "doubly inhibited", and will give the user longer service life than could otherwise be expected.

### Other Treatments

The foregoing are not the only treatments given to special purpose oils where operating conditions or requirements incidental to certain mechanisms may require them. We refer to pour point depressants, oiliness agents, V. I. improvers, antifoam agents and E.P. additives. As a general rule, however, such properties are not required in ordinary industrial hydraulic oil service.

Sufficiently low cold test, adequate Viscosity Index, and lubricity to the extent usually found in a quality hydraulic oil is generally incidental to a well balanced, highly refined product.

Sometimes additives used for imparting such characteristics as oxidation resistance or gum solvency may also impart one or more of the above properties as incidental to their primary purpose.

One feature of an additive-treated oil that is of prime importance to all reputable marketeers of hydraulic oil is the careful measures taken to make certain that the additive chosen is entirely compatible with the base stocks employed. Experimentation in the user's shop with "additives" to be blended with untreated oils may well lead to disastrous results. One large pump manufacturer today warns of such local treatments, although testifying to the value of correct additive treatment when done by an oil supplier. There is much more to treatment of a hydraulic oil than the mere adding of a percentage of rust preventive, oxidation inhibitor or solvent additive.

One such case on record is that of an oil man, who, fearing his customer was about to change to another supplier because of features found in treated oils, stated that he too could provide treated oils simply by adding a given percentage of an additive that he would supply. Fortunately, before following the first oil man's advice, the user dug deeper into the matter, and was convinced that trouble might occur if he went into the oil blending business himself.

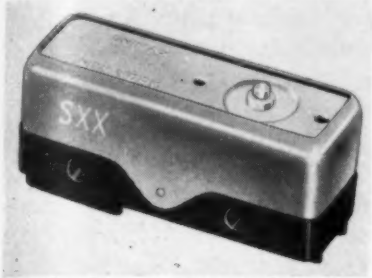
Additives in hydraulic oils are not just accidental discoveries, but are the fruits of years of tireless laboratory work plus field testing in full-scale production equipment. They *are* based on scientific development work, and they *will* give the user long, trouble-free life.

(Continued from page 51)

contacts, preventing oxidation. Interchangeable heaters in a wide range of ampere ratings are available. *15.*

### Precision Switch

A new snap-acting precision switch, type SXX Unimax is offered by the Unimax Switch Division of the W. L. Maxson Corp. The new switch is rated at 15 amps, 250 volts ac; 20 amps, 125 volts ac; ¾ hp, 125, 250, 460 volts ac. Force and movement specifications are:



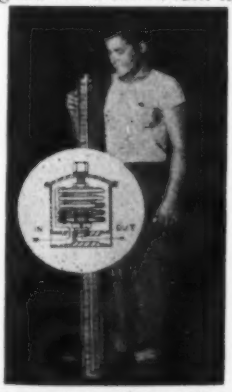

operating force, 9-13 ozs, release force, 4 ozs min movement differential, .005 in max; pretravel, .025 in max, overtravel, .005 in. The new switch can be adapted for a variety of actuating means. *16.*

### Air Pumps

The Kraissl Company announces their new Class 23 Series air pump for suction and pressure applications. Originally designed for the packaging and printing machinery fields, the new dry lubricated pumps are now available for paper handling, food processing and other uses where oil vapors contaminate. The pumps are fan cooled and available with double extended shafts for group mounting. They operate at 1750 rpm and range from 5 cfm to 20 cfm for single units. Higher speeds and greater capacities are available. *17.*

### Porous Steel Filters

Micro Metallic Corp. announces the new Surfamax porous stainless steel filters. These permanent filter elements in the form of corrugated assemblies are designed for a maximum filter area

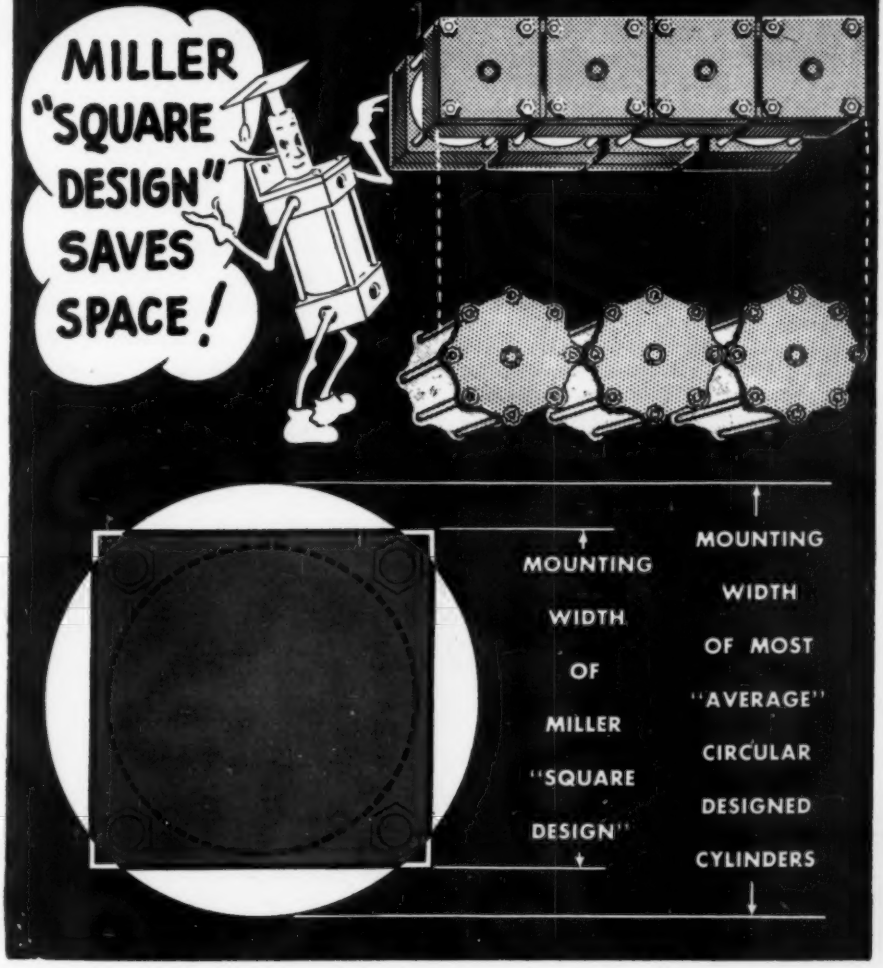


in a convenient small container to give continuous service with a minimum of maintenance. Available in six pore openings, 5 microns to 165 microns the standard units have pipe connections ranging from ¼ in to 2 in; special sizes to 10 in and capacities up to 10,000 gpm. *18.*


Miller

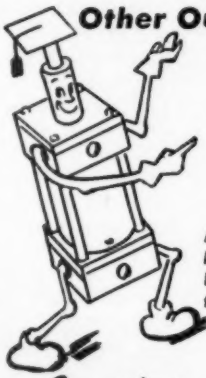
Air Cylinders
Hydraulic Cylinders

MILLER "SQUARE DESIGN" SAVES SPACE!






Other Outstanding Miller Standard Features . . .



- SOLID STEEL HEADS, CAPS, MOUNTINGS. Eliminate breakage.
- HARD CHROME PLATED PISTON RODS. Resist nicks, scoring.
- DIRT WIPER SEALS. Keep out abrasive dirt.

*Miller High Pressure Hydraulic Cylinders meet the "J. I. C." Hydraulic Standards, the "quality" standards recently approved by the Joint Industry Conference (J. I. C.) of leading manufacturers and users of hydraulic equipment.*

Complete Line

- AIR CYLINDERS 1½" to 20" Bores
- LOW PRESSURE HYDRAULIC CYLINDERS 1½" to 14" Bores
- HIGH PRESSURE HYDRAULIC CYLINDERS 1½" to 12" Bores

Single and Double Acting, Single and Double Rod End, Spring Return, Cushioned and Non-Cushioned, Over-Sized Rod, and Long Stroke Cylinders in All Mounting Styles.

write for
Miller Air Cylinder Bulletin A-105 and Miller Hydraulic Cylinder Bulletin H-104

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DRYSEAL
THREAD
PRESSURE PLUG

. . . seals pressure-tight without the use of sealing compounds. Features the "Dryseal" Pipe Thread originally developed for use with $SO_2$, ammonia, and other refrigerants. Offers a valuable solution to leakage problems in high pressure equipment of all kinds.

Unique design of the "Dryseal" Thread provides actual crushing and sealing at both major and minor diameters, effectively preventing spiral leakage, even under extreme pressures.

Incorporates all the important features of the regular UNBRAKO Pressure Plug, including fully formed threads, uniform taper and perfect roundness.

A full range of sizes from 1/16" to 1¼", National Pipe Thread Fuel, is available. Full details are given in Bulletin 675.

See us at Space 128, A.S.T.E. Exposition April 10-14, Convention Hall, Philadelphia

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# POST SCRIPTS OF INDUSTRY

## NEWS · VIEWS · TRENDS

Greer Hydraulics, Inc., announces the opening of a district office in Chicago. William P. Hall will be in charge as district sales manager and will service industrial accounts.

Purolator Products, Inc. announces the appointment of W. Herbert Hultgren as assistant chief engineer.

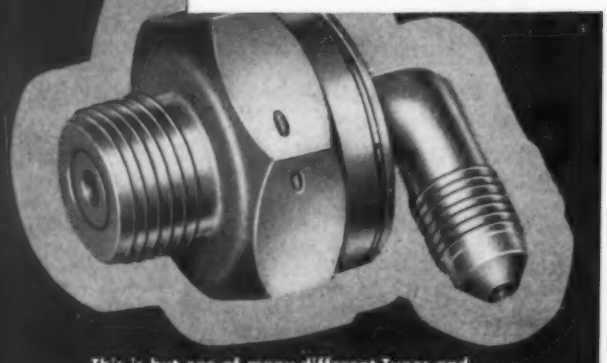
Louis Mohn, formerly district sales manager Pittsburgh territory, has been named general sales manager of the Garlock Packing Co., replacing Phil Arnold who has retired from sales. Eugene G. Flannery will take over as district manager of the Pittsburgh territory.

Carl L. Sadler, Jr., has been appointed chief engineer of the Hydraulic Division of Sundstrand Machine Tool Co. Sadler has been associated with Sundstrand for the past two years as assistant chief engineer. Formerly he was group engineer in charge of control and accessory developments at Westinghouse Electric Co. in Philadelphia.

Airoquip Corporation announces Byron E. Snow as the new sales engineer for their Chicago territory which includes Illinois, Iowa and southern Wisconsin. He will service manufacturing accounts and will have his headquarters at 380 Elizabeth Drive, Lombard, Ill.

The Belfield Valve division, Minneapolis-Honeywell Regulator Co., has added four men to their field sales staff: Russell A. Schlegel, for the eastern region, with headquarters in New York; George Brown, for the central region, with headquarters in Cleveland; Robert Scott in the midwest region, with headquarters in Chicago; and William

CHIKSAN
HYDRAULIC
SWIVEL JOINTS



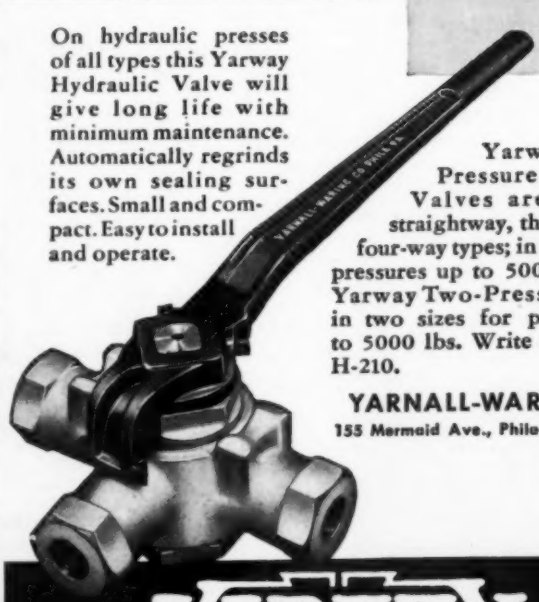
This is but one of many different Types and Styles of CHIKSAN Hydraulic Swivel Joints for application on all hydraulic lines which must turn or swivel. Pressure capacities range from 1000 psi. to 3000 psi. Write for Bulletin A. Or tell us your requirements and CHIKSAN Engineers will gladly cooperate with you in developing Hydraulic Swivel Joints to meet your requirements.

CHIKSAN COMPANY
AND SUBSIDIARY COMPANIES
Chicago 3 · BREA, CALIFORNIA · New York 7
WELL EQUIPMENT MFG. CORP. HOUSTON 1, TEXAS
CHIKSAN EXPORT CO. BREA, CALIFORNIA · NEW YORK 7

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

The Higher the Pressure
...the Tighter the Valve

On hydraulic presses of all types this Yarway Hydraulic Valve will give long life with minimum maintenance. Automatically regrinds its own sealing surfaces. Small and compact. Easy to install and operate.



Yarway Single-Pressure Hydraulic Valves are made in straightway, three-way and four-way types; in five sizes for pressures up to 5000 lbs. Also Yarway Two-Pressure Valves in two sizes for pressures up to 5000 lbs. Write for Bulletin H-210.

YARNALL-WARING CO.
155 Mermaid Ave., Philadelphia 18, Pa.

YARWAY
Improved Type
HYDRAULIC VALVE

Clements, the Pacific coast and mountain regions, with headquarters in Los Angeles.

Delbert G. Faust has been appointed chief engineer of the C. A. Norgren Co., it was announced recently by Carl A. Norgren, president. D. G. Faust has had extensive engineering experience with the Walter Kidde Co. where he was chief project and test engineer for the last 14 years. In his capacity with Norgren he will be in charge of all research and engineering activities in the development of new pneumatic products of the Norgren line.

Mr. Faust

Air Associates have expanded their nation-wide distribution system by establishing a new sales and warehouse facility at International Airport in Miami, Florida. Robert E. Ringle will operate the new service.

F. C. Norris, vice president in charge of manufacturing and engineering for Denison Engineering Co., has been named as General Manager of the Company. C. A. Hughes, plant superintendent, was made a vice president and general works manager.

L. W. Jefferies, general manager, Mechanical Air Controls, Inc., announces a consolidation of the sales, engineering and manufacturing facilities of the company at a new location, 5427 Hecla Ave., Detroit 8, Mich.

Mercer Rubber Company, 1601 Maury St., Houston, Texas, has been appointed manufacturer's representative for Texas, Oklahoma, Arkansas and Louisiana by Hose Accessories Co., Philadelphia. W. H. Sayen III is head of the Mercer company and H. A. Vitriol is manager of the Houston office.

J. O. Becker has been appointed sales manager for Advance Pump Co. it was announced by J. N. Gilman, president. He brings with him to Advance more than 20 years of water system manufacturing and sales experience. His headquarters will be at the company's main office in Berkeley, Cal.

Lear, Inc., announces the appointment of R. S. Atkinson as sales manager of its Romec Division, located at Elyria, Ohio. He formerly was with American Airlines as supervisor of accessory engineering and maintenance.

Formerly supervisor of the Torque Converter Unit at Ford Motor Co., John H. Swift is now a transmission engineer in the advanced engineering department of the Truck Division, International Harvester Corp.

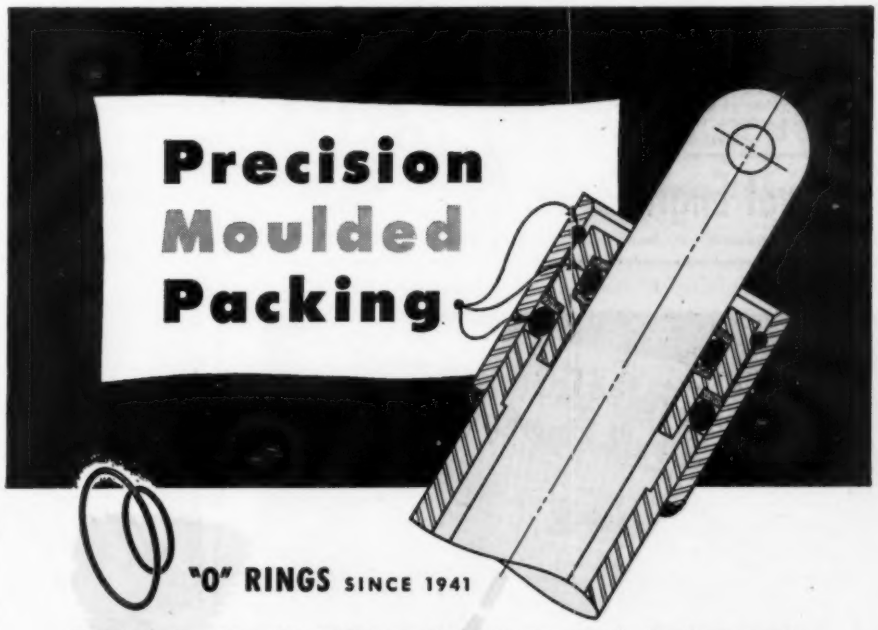
Miller-Joyce, 122½ S. Vermont St., Los Angeles, Calif., and Whitty Engineering Co. of 10 High Street, Boston, Mass., have been named by the Birdsboro Steel Foundry and Machine Co. as manufacturers agents. They will handle hydraulic presses and related equipment in their respective territories.

James D. Cunningham, president of Republic Flow Meters Co., has been announced as the recipient of the 1950 Merit Award "for outstanding engineering, administration and civic service" given by the Chicago Technical Societies Council. The presentation will be made by Dr. Gustav Egloff at a Council dinner in May.

*(Continued on page 64)*

**Submit Your Ideas**

***Tell us "Here's How" you do it at your plant. Sketch or jot down your labor-saver and send it in to the Editor—It may be worth $10.00. Every item published is worth $5.00, the best-of-the-month $10.00.***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**From "0" rings to hydraulic accumulator bladders, Plastic and Rubber Products Co. *of Los Angeles* has for many years been successfully making precision packing for the hydraulic and pneumatic industries. The development of compounds of outstanding quality and performance are directly responsible for such success. Parco Balanced Compounds are used in all of our precision moulded packings. For "0" ring packing, investigate "0" rings from Parco Balanced Compounds. All dash numbers of both 6227 and 6230 series for commercial application or Army-Navy installations to Specification ANP 79 are available from stock.**

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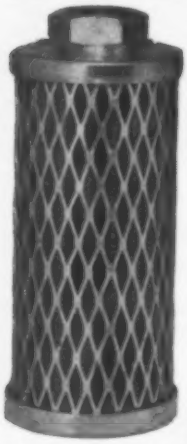

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an exacting field!

MARVEL SYNCLINAL FILTERS

*Over 90 Manufacturers of HYDRAULIC MACHINES have picked Marvel filters as O.E.M. choice to guard their product.*

**2½ Times the Filtering Area of Like Size Circular Type Filters**

Dirt and foreign matter in oil cause over 50% of hydraulic machine troubles. Damage to pump gear, clogged ports and improperly seated valves result in pressure losses and slow unreliable action. Easily installed, and requiring minimum care, Marvel filters have cut maintenance costs up to 40% while effecting more and better production. Capacities (5 to 50 G.P.M.) and mesh sizes (Coarse 30 to fine 200) available in both liquid line and sump types include the correct filter for your machine.

For efficient filtration of non-corrosive liquids in circulating and low pressure systems, Marvel has your answer. Write for catalogs 104 and 202

Marvel Engineering Co.
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# APPLIED HYDRAULICS DIGEST

**Abstracts, summaries and listings of articles on hydraulic and associated applications in industry; reports on prepared papers, talk and discussions pertinent to the hydraulics field.**

### Tracing Causes of Sludges and Deposits in Lubricating Systems

**J. S. Wiberley and James B. Rather, Jr.,** *Lubrication Engineering,* v 6, February 1950, pp 11-15.

A description of the microchemical techniques used to analyze small samples of sludges and deposits taken from lubricating systems. The procedure followed by Socony-Vacuum Laboratories, Technical Service Department is given in some detail. Samples are examined by either a stereoscopic (10X) or a chemical microscope (100 to 200X), the sample ignited and a quantitative determination of the ash content made, particularly to identify the contained metals. Small deposits are immersed in petroleum ether and chloroform is

- Full Line Capacity
- Positive Seal
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FILTER element removes solids .00039 and larger. TRANSPARENT BOWL provides visibility. REGULATOR is capable of passing large volume with an unrestricted flow and minimum amount of pressure drop. Self-bleeding, compact, simple. Machined from bar aluminum. LUBRICATOR delivers desired volume of oil. Adjustable Venturi Valve permits efficient operation on broad range of volume and pressure. Bowl can be refilled without shutting off air supply. Any of these 3 devices can be used as separate units or in any combination.

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130-134 E. Larned St.
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quantitatively determined in a glass centrifuge cone. The residue of the petroleum ether extract is inspected to make certain it contains nothing but the original lubricant. Neutralization (ASTM D974-48T) and saponification (ASTM D94-48T) numbers are determined. Oxidized oil may be indicated by appearance, odor on heating and the neutralization and saponification numbers. Suggestions are given for the qualitative organic analysis of other materials. Typical analyses of turbine deposits and those formed in electric clock motors are given in detail. The authors conclude that micromethods are invaluable in the investigation of the nature and causes of sludges and deposits formed in lubricating systems.

### Driving Aircraft Accessories Remotely From the Aircraft Engine

**H. R. Snows,** *Technical Data Digest,* v 15, 1 March 1950, pp 16-25.

After establishing by case histories the fact that there is a real need for remotely driven accessories, the author cites the advantages, then covers the methods by which this may be done. Hydraulic, pneumatic, electrical, mechanical, auxiliary power plant, ram air engine and chemical, steam or bottled gas are listed as the possibilities, the last two being applicable only to rocket, ramjet or pulsejet engine. A schematic diagrams shows the Sundstrand hydraulic transmission, which is essentially a hydraulic pump and motors with controls, reservoir, cooler and fittings. This system has been tested sufficiently to insure satisfactory operation, transmitting up to 50 hp. The hydraulic system can be used


VALVAIR- has an Air Control Valve
... FOR EVERY AIR CONTROL NEED

Adaptability, efficiency and dependability are had with "Valvairs" because of their many exclusive features. The unique "OU" type packer seals more effectively and lasts longer. No metal seats. Standard pipe area through the valve permits unrestricted air flow and prevents pressure loss. Flexible design allows virtually any desired control assembly. Rely on and profit by operation with "Valvairs".

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*Lever-operated, 3-way piped exhaust valve illustrated.*

The VALVAIR line includes cam-, knob-, clevis-, foot-, treadle-, cylinder-, diaphragm- and solenoid-operated air control valves.

For use with air, water or oil pressures up to 175 lbs. p. s. i. and temperatures up to 120°F. 2-way; 3-way and 4-way open-end exhaust; 3-way and 4-way piped exhaust.

Sizes: ¼", ⅜", ½", ¾", 1"

*Ask for Folder "A-H"*

VALVAIR CORPORATION • 454 Morgan Avenue, Akron 11, Ohio
AFFILIATE: SINCLAIR-COLLINS VALVE CO.

Rely upon Valvair — 2-WAY — 3-WAY — 4-WAY



THE NEW OILGEAR "JK"
FLUID POWER FEED PUMPS

ARE SO EASY TO APPLY
To *New* or *Old* Machines

Simply connect a new, small Oilgear "JK" Feed Pump to an Oilgear cylinder and an Oilgear engineered control and you have a complete pushbutton and switch-controlled fluid power system. No hydraulic or electric application engineering is required. Merely follow standard recommendations in mounting units, connect pump to cylinder with two pipes and wire two solenoids on pump to electric controls. Oilgear supplies the feed pump, cylinder, control cams, limit switch panel, control panel and pushbutton station. Oilgear provides patented, tried and proven hydraulic and electric circuits.

You can improve your new and old machines without further congesting your engineering department or employing hard to get qualified hydraulic engineers. You cut production and assembly costs because NO mechanical control linkages . . . NO auxiliary valves, pipes or fittings are required. You do not have to risk delay, disappointment or malfunctioning. You avoid divided responsibility. You receive the full values inherent only in 100% Oilgear systems.

*No other single change in a machine can contribute so much to simplified design, reduced costs or improved performance as the installation of the "JK" feed system.*

Bulletin 44200 describes this small, compact packaged unit that incorporates feed pump, rapid traverse gear pump, control and relief valves as an integral unit; other features described are: wide range of feeds . . . consistently maintained pre-set feed rates, ease of servicing without disconnecting pipes or draining oil reservoirs, etc. Send for this bulletin today. THE OILGEAR COMPANY, 1564 W. Pierce Street, Milwaukee 4, Wisconsin.

Oilgear Fluid Power
PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

Protect
HYDRAULIC EQUIPMENT
WITH HIGH PRESSURE
MICRONIC FILTERS

• 3000 p.s.i. Operating Pressure, Micronic Filtration, Low Pressure differential, Compact in Line Type

• Maximum Protection at minimum cost. Replaceable element.

West Coast: H. E. Webb
918 N. Kenilworth Ave., Glendale, Calif.

WATERMAN ENGINEERING Company
721 CUSTER AVENUE • EVANSTON, ILLINOIS


as a starter for the engine by reversing the use of the pump and motor. A pneumatic system, illustrated and described, is a system which is air-bled from the main propulsion engines and directed to air turbines, which in turn drive the accessories. The very low rate of air bleed does not affect overall engine performance. The maximum power on long range bombers is very intermittent. The electrical system is designed for a factor of safety of two at peak loads and very little power is required during cruising. Several types of flexible joints that are available for aircraft power transmission are shown and described. The author predicts that within five years all cargo and bomber airplanes will be provided with remotely driven accessories and states that pneumatic transmissions will take the lead over hydraulic transmissions until a noncombustible hydraulic fluid is developed, after which the two methods will be very competitive.

### Fluid Couplings and Torque Converters for Industrial Equipment

**Anonymous,** *Lubrication,* v 36, February 1950, pp 13-24.

The entire editorial content of this issue is devoted to a survey of five fluid couplings and four torque converters. The American Blower Corporation, Chrysler Corporation, Craneveyor Corporation, Link-Belt and Twin Disc Company fluid couplings are briefly described and illustrated and the lubrication instructions of each manufacturer given; the Twin Disc, General Motors, Torcon and Thomas VariDRAULIC drive units are shown. The first three are clutch and trans-

Light toe pressure

. . . instant action

This compact "all-purpose" N.P. foot-operated valve for compressed air control is actuated without effort. Applies pressure with pedal up or pedal down, by simple arrangement of piping. Pedal is shielded for safety. No sticking . . . no air leaks . . . fast, trouble-proof operation. Write for Bulletin DC-203.

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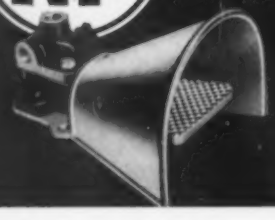

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Hydraulics
that fit your problem

Every year sees greater use of hydraulics.

Each year passed has added to our own extensive store of hydraulic know-how.

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Builders of the famous Hufford Hydraulic Stretch-Wrap Forming Machines, Hydraulic Ceramic Presses, Hydraulic Elevators, and Specialized Hydraulic Machinery.

mission or complete torque converters; the Thomas unit transmits torque but does not multiply it, and is capable of exerting maximum torque at the most efficient driving member speed. Tables give lubrication instructions of the converters.

### Notes on Pneumatics

**E. Stolarik,** *Aero Digest,* January 1950, pp 45-49.

A means of improving and simplifying pneumatic design procedures by curves which show the functional relationship between the variables involved in pneumatic circuits for aircraft computing devices and controls. Major attention has been given to parametric variation of airflow through circular and rectangular orifices and through capillaries into volumes and time-constant circuits as functions of pressure temperature and physical dimensions.

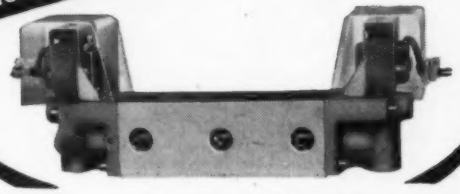
### Rotary Pistons in New Hydraulic Pump Design

**Roger W. Bolz,** *Machine Design,* v 22, February 1950, pp 116-118.

Design details of one of the most recent developments in the hydraulic field—a hydraulic transmission system invented by Frank Berry and manufactured by Berry Motors Inc. The pump is basically very simple, making for low cost and virtually eliminating wearing parts. Two rotary pumps are geared to and mate with a central rotary abutment. The abutment rotor and pistons rotate without frictional contact with any surface, supported by antifriction bearings. Snug rolling contact is maintained between the cylindrical surfaces of the abutment rotor and both piston rollers. During


another NEW Quick-As-Wink development

Type "DS" double solenoid pilot operated single plunger control valve



▶smaller, shorter stroke solenoids—lower amperage
▶simpler electrical controls — high air economy...

● Small solenoids traveling through only a 1/8" stroke move small pilot valve plungers to apply air to operating pistons that move the main valve plunger back and forth. All operating parts are rugged, yet weigh only a few ounces. Reduced amperage eliminates intermediate relays, simplifying control circuits. Positive high cycle operation, without destructive impact, reduces maintenance and minimizes trouble due to voltage variations. 3/8" to 2" sizes. 2, 3, and 4-way actions. Solenoid control both directions or automatic return in one direction. *Send for Data Sheet No. 1611. It gives full details.*

Write today!

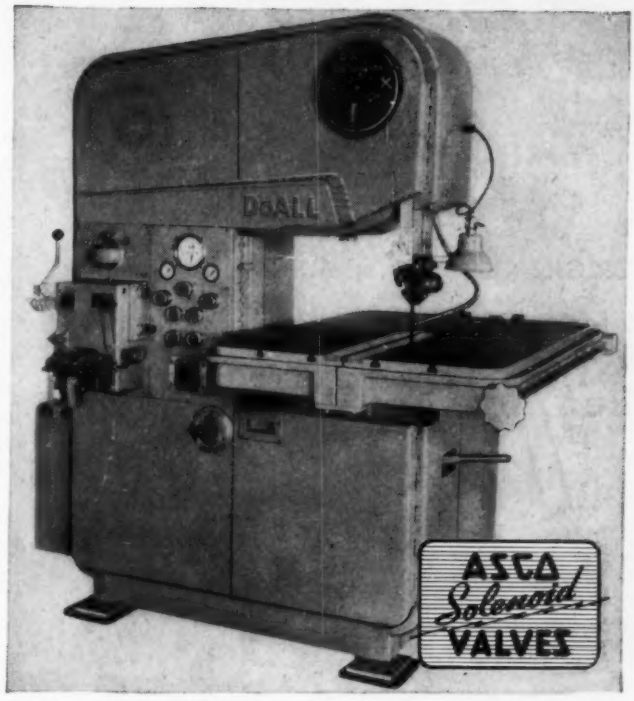
Mfd. by C. B. HUNT & SON, Inc., 1962 E. Pershing St., Salem, Ohio

"The Higher the Pressure — The Tighter the Seal"

Quick-As-Wink

AIR AND HYDRAULIC CONTROL VALVES

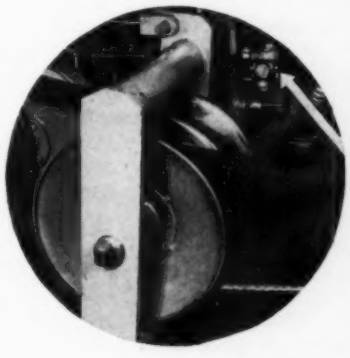





AUTOMATIC SAFETY FOR THE "CONTOUR-MATIC"

The DoALL Company, Des Plaines, Illinois has developed a most ingenious yet practical machine for contouring and shaping solids quickly and with elimination of chip waste.

Operational safety is provided in part by an ASCO 3-Way Solenoid Valve. It is used in the brake circuit and is open during machine operation allowing the oil to circulate. When the machine is turned off—or if a blade should break—the current to this solenoid valve is cut off which checks the flow of oil through the brake circuit, thus forcing the hydraulic oil into the brake cylinders which actuates the brakes and, in turn, stops the wheels.



So much in the way of automatic control—including remote control—with solenoid valves is being done that you should investigate them fully for controlling the flow of any gas or liquid in the machine you are designing. ASCO Engineers will be glad to recommend the proper type for your problem, as they have for hundreds of others. In writing, be as detailed as possible.

ASCO Solenoid VALVES

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.

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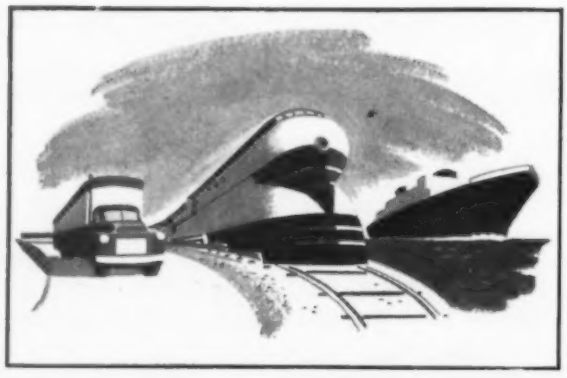
ORIGINATOR OF **MICRONIC** FILTRATION

the *Finest*

## Answer to Any Filtering Problem



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### An Evaluation of Dryseal Pipe Threads

**R. F. Holmes,** *The Tool Engineer,* v 24, February 1950, pp 17-19.

A brief analysis of three specifications for truncation at root and crest as shown in American Standard Pipe Threads B2.1-1945 and National Bureau of Standards Supplement to Handbook H-28 (1944). Dryseal pipe


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thread design specifications for thread form truncation at root and crest allow no clearance at these points when the flanks engage. The minimum truncation at the root gives some interference with the minimum truncation at the crest. The limits of truncation at root and crest are reduced to amounts considered practical for manufacturing. In the makeup of the joint, the roots and crests contact at hand engagement and additional tightening by wrenching crushes the roots and crests to bring the flanks into engagement. It is this feature which eliminates the need for a sealer.

The American Standard Dryseal Taper Pipe Thread (NPTF) and American Standard Regular Taper Pipe Thread (NPT) are shown schematically and tables give both pipe thread truncation clearance and interference for these and AN-P-363 Aeronautical Specifications. Tools and gages for Dryseal taper pipe threads are briefly treated and the operation of a comparator for checking is described.

### Special Machinery Pays Off

**C. A. Nichols,** *Steel,* v 126, February 13, 1950, pp 84-88, 110, 112, 115, 116.

The master mechanic, Delco-Remy Division, General Motors Corp., Anderson, Ind. plant presents a very convincing case for the special machine that increases quality, decreases cost or reduces fatigue. He makes a point of the fact that designers have a different viewpoint in regard to their machines and that the production viewpoint is essential in training operators and maintenance men. A good analysis of the cost estimate for special machines, from the standpoint of the pro-


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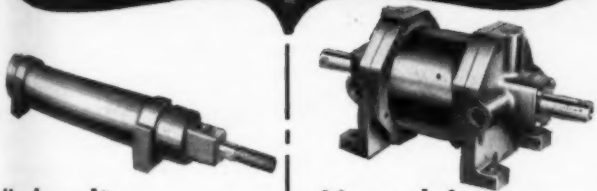

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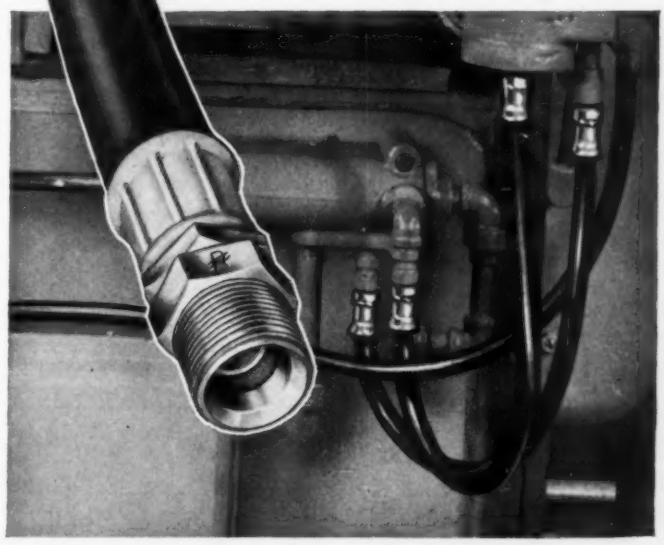

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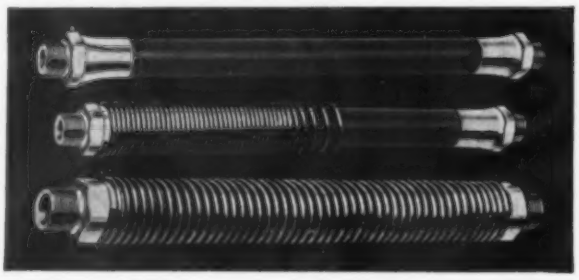

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duction engineer, the procedure of developing machines, catching mistakes, making machines work and the keeping of performance records are well covered. Several good examples are given which indicate that hydraulics are playing an important part in the design and operation of special machines.

### Hydraulically Operated Double-Draw Die

**L. D. Richards,** *Machinery,* v 56, January 1950, pp 185-186.

The use of an auxiliary, portable, hydraulic unit to act as a hold-down in single action type of press for a draw and redraw is described. Both functions are performed in one operation, an air cushion with an unusually long stroke being used to permit the down stroke to continue after the first draw is completed. The material drawn is 52S-O aluminum, 0.32 in thick, fed to the press in coils and drawn into shells to a depth of 3⅜ in, with an outside diameter of 2 inches. A diagram and a detailed description of the operation are included.

### Marform Units Made Available to Industry

**Anonymous,** *The Martin Star,* v 9, February 1950, pp 10, 11, 12, 18, 19.

A description of the Marform process, developed by the Martin Company, with an excellent group of photographs. The Marform process combines the traditional deep drawing techniques with the advantages of the Guerin process, developed during the war and widely used for short run forming of aluminum sheet. The process utilizes the same simple male punch employed in the Guerin process, but it also requires a flat plate

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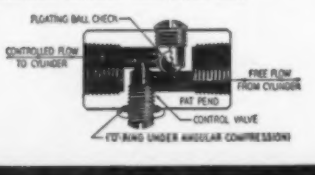


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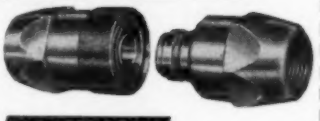

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on which the metal rests, making it unnecessary to make a female die, pressure plate or draw ring. The Marform punch can be made of Masonite for short runs or of cast Kirksite for longer runs or harder materials. Deep draw in one operation, precision part tolerances (plus or minus .002) and ability to form very thin materials (.010) and ability to handle tapered shapes without wrinkling are among the advantages cited. The Martin Company has made an arrangement with a leading hydraulic press manufacturer, Hydropress, Inc. of New York to manufacture and sell the Marform units.

### Production Road

**Logging Issue** of *"Production Road"*, house organ of Twin Disc Clutch Company.

This attractive, generously illustrated booklet surveys the changes that have taken place in the logging industry as modern equipment came into use. Many basic pieces of equipment—cranes, pulp wood loaders, tractors, yarders, peelers, gang saws and others utilize Twin Disc clutches, couplings, power take-offs and converters. Illustrations show a wide variety of operations and processes in the modern logging camps. The saga of modern logging is taken from the power chain saw to the paper mills.

### Rotary Pumps

**H. G. Conway,** *Machine Design,* v 22, January 1950, pp 104-105.

This third in a series of articles by the technical director of British Messier, Ltd., discusses and illustrates several early designs of gear and vane pumps.


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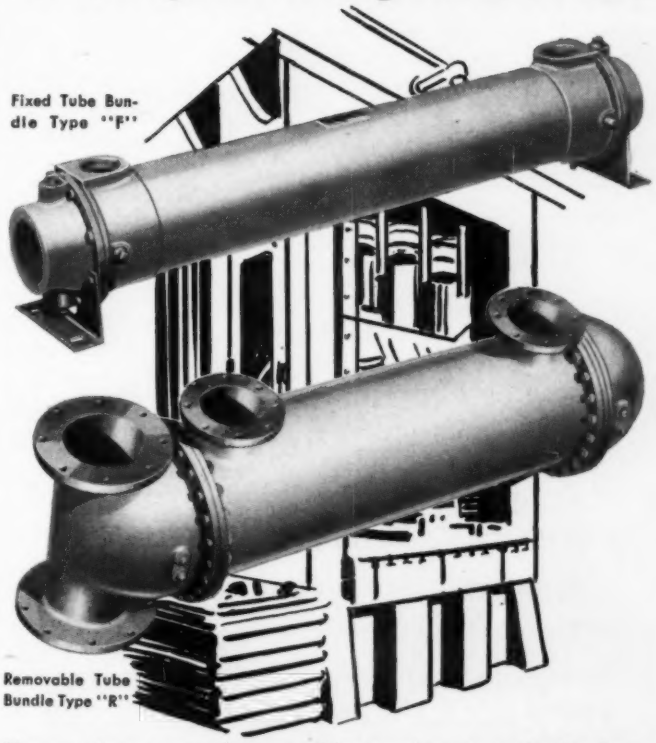

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*(Continued from page 55)*

Mac Neel Pierce, president of Plastic & Rubber Products Co., of Los Angeles, announces the opening of an office and warehouse in Chicago at 919 North Michigan Ave., with M. A. Brown in charge. A complete line of commercial and aeronautical "O" rings will be handled.

The Syntron Company has moved its New York Area office from Long Island City to 1860 Broadway, New York.

E. J. Edson, 1405 Hoyt St., Muskegon Heights, Mich., has been appointed exclusive sales agent for western Michigan by the Fox Engineering Company of Jackson, Mich. The Bert Carpenter Company will continue to represent the company in eastern Michigan.

Eastern Engineering Company has announced the appointment of the Chemical Pump and Equipment Corp. as their District Representative in the New York Area. Robert T. Sheen is president of the newly appointed corporation and has his headquarters at 75 West St., New York.

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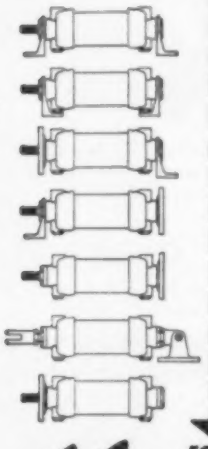

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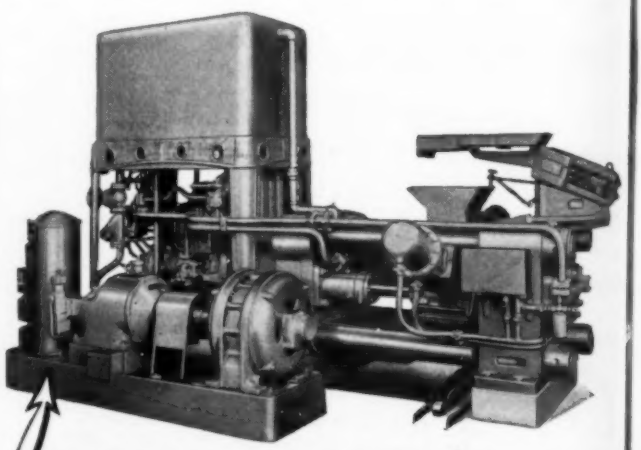

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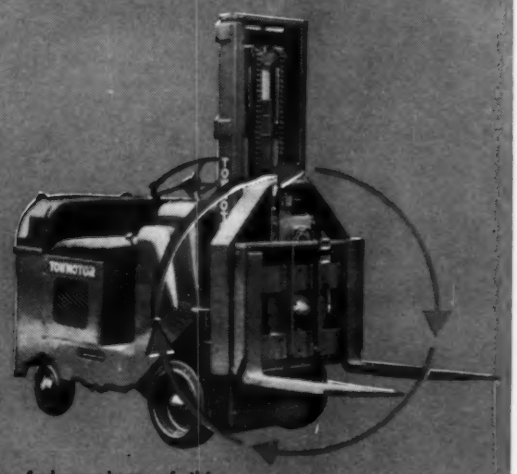
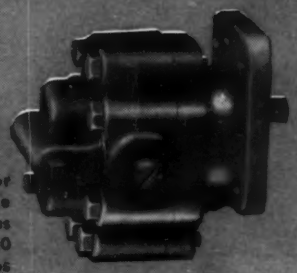


The fork carriage of this Towmotor model revolves 360 degrees in either direction.



The hydraulic motor which revolves the Towmotor carriage has a displacement of 1.0 cu. in. and develops 14.5 in.-lbs. torque per 100 p.s.i.

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